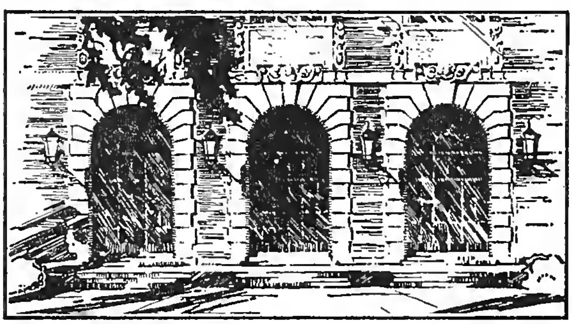

Winter, 1964

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Cows set new feeder into operation as they drink water

A medium pressure pneumatic system for conveying feed

Large-scale farms are only a small part of Illinois agriculture

Chemicals for control of root rot fungi

Laboratory testing of pigs' blood reveals existence of many blood types and provide information for use in a breeding program — page 12

Volume 6, Number 1 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

Winter, 1964 Volume 6, Number 1

Published quarterly by the University of Illinois Agricultural Experiment Station

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M. B. Russell..............Associate Director

Adrian Janes.................Station Editor

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DEANS OF THE COLLEGE OF AGRICULTURE: HENRY P. RUSK

Henry P. Rusk, fifth Dean of the College of Agriculture, once said: "Progress depends upon getting the facts and then putting these facts to work." And Rusk's success in convincing farmers that they must put the results of research into actual practice constitutes perhaps his most significant contribution to Illinois agriculture.

Rusk was born on a farm near Rantoul, Illinois, in 1884. He was graduated from Valparaiso University in 1904, and from the University of Missouri in 1908, and received his M.S. degree from Missouri in 1911. After teaching for one year at Purdue University, Rusk came to the University of Illinois in 1910 as associate in beef cattle husbandry and first assistant in the Experiment Station. His skill as a judge of livestock and his research in cattle feeding soon earned him a wide reputation among scientists, stockmen, and farmers. He succeeded H. W. Mumford as head of the Department of Animal Husbandry (now Animal Science) in 1922, and was appointed Dean of the College of Agriculture upon the retirement of J. C. Blair in 1939.

Among the important achievements of Dean Rusk's administration were the establishment of the College of Veterinary Medicine and of the Dixon Springs Experiment Station. During his 13 years as Dean, he also served on many national committees, boards, and commissions. In 1948, he was selected by former President Herbert Hoover to head the Agricultural Task Force of the Commission on Organization of the Executive Branch of the Government.

Dean Rusk received many honors during his lifetime, including the Distinguished Service Award of the American Farm Bureau Foundation, the Distinguished Service Ruby of Epsilon Sigma Phi, Doctor of Science degrees from Purdue University and the University of Missouri, and the Doctor of Laws degree from Illinois Wesleyan University. Even more important than these were the deep respect and affection in which he was held by all who knew him. When Rusk died in 1954, Herbert Hoover described him as "a great American and . . . fine public servant." But probably the tribute Henry Perly Rusk would have liked best came from a farmer. "He was," the farmer said, "one of us." — *Richard G. Moores*

A NEW FEEDER FOR DAIRY CATTLE

delivers concentrate according to the amount of water a cow drinks

K. E. HARSHBARGER and E. F. OLVER

A NEW type of feeder for dairy cattle is based on the fact that water consumption, feed consumption, and milk production are all interrelated.

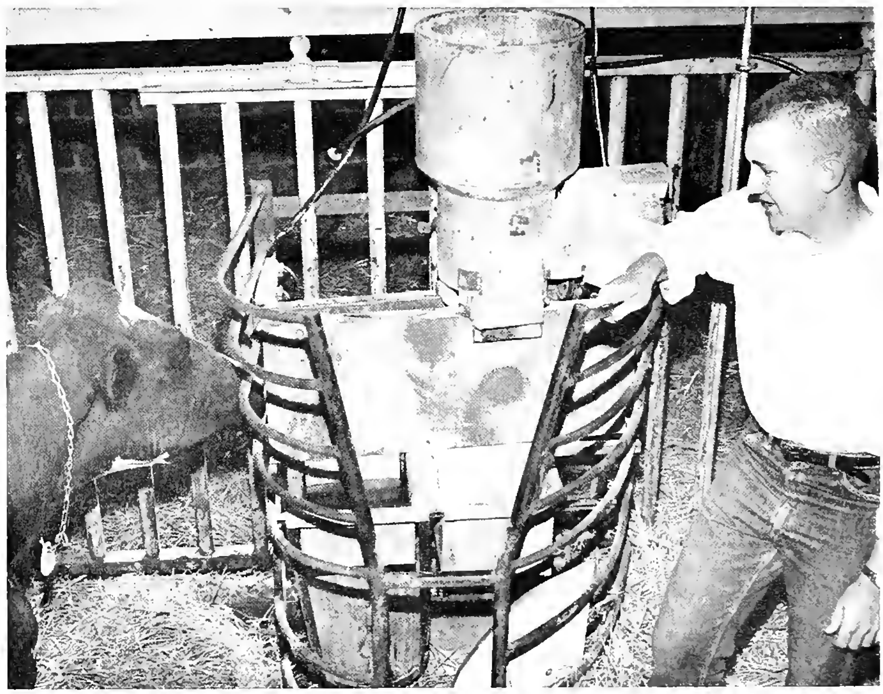
Since milk is 87 percent water, a dairy cow obviously needs plenty of water for milk production. In addition, like any other animal, she needs water for bodily functions: digestion and absorption of feed nutrients; transportation of oxygen to the tissues and of carbon dioxide away from them; removal of waste products; and regulation of body temperature.

An animal gets some water from the moisture in feed and through metabolic processes. Succulent feeds such as silage and lush pasture usually contain 65 to 85 percent water. Metabolic water resulting from the oxidation of feed nutrients may amount to about half of the digestible organic matter. In addition, the animal needs free water to supply its complete water requirement.

Several factors influence the amount of water a cow drinks. On dry feeds, she drinks 3 to 4 pounds of water for each pound of dry matter she eats, plus the amount of water in the milk she gives. Thus, as milk production goes up, the cow's water requirement, as well as her feed requirement, increases. In hot weather, the cow needs extra water to control body temperature.

The basic facts about water requirements and utilization suggest that a cow's water intake can be used to limit or control the amount of grain she gets. A mechanical device

K. E. Harshbarger is Professor of Nutrition, Dairy Science Department, and E. F. Olver is Associate Professor of Agricultural Engineering.



This feed-metering device delivers grain to a dairy cow on the basis of her water consumption. As the cow drinks, a float in the trough (left) drops and starts an electric motor which delivers a pre-determined rate of feed to the feed trough (right). Water flow and feed flow start and stop together. (Fig. 1)

that feeds a cow grain in proportion to the water she drinks would provide an automatic grain-feeding system.

Machine developed

About two years ago, Gordon Strite of Belleville developed a water-controlled grain feeder on the basis of the facts outlined above. He offered this prototype feeder to the University for use in research on automated feeding of cattle.

We modified the machine and developed it into the one shown in Figure 1. Since it meters grain on the basis of the cow's water consumption, the cow gets grain in proportion to her milk production insofar as water consumption is directly related to milk consumption. In practice, this feeder could be placed in a loose housing operation and each cow fed automatically in proportion to her milk production.

Three tests

So far three tests have been conducted on each of three cows. The tests were as follows:

Test 1. The feeder and waterer were placed side by side (Figs. 1 and 2). As the cow drank from the waterer, a float activated both a

solenoid which allowed water to flow, and a motor which allowed feed to flow. The flow of feed and water started and stopped at the same time.

Test 2. This was the same as test 1, except that a partition was placed between the feeder and waterer so the cow couldn't see the feed being delivered while she drank water.

Test 3. A reservoir and float were added to the arrangement used for test 2 (Fig. 3). As the cow drank, the float in the waterer dropped and opened the solenoid valve, allowing water to fill the reservoir. When the reservoir was filled, its float activated a switch that started the feeder. Thus feed delivery was delayed until after the cow had drunk part of the water.

Promising results

Milk production was maintained in all three tests (see table). The principle of feeding concentrates to cattle on the basis of their water consumption therefore appears to be sound.

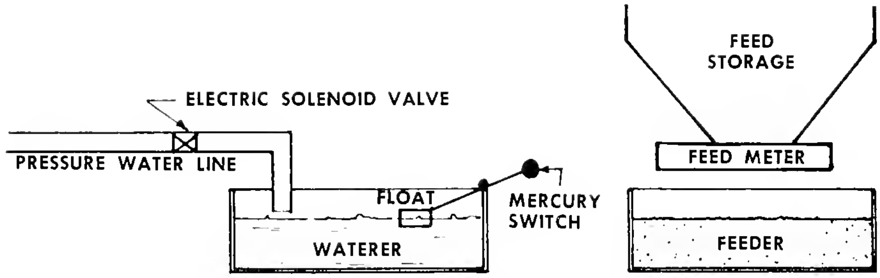
In test 3, when the reservoir and the partition between feeder and waterer were used, the cows went to the waterer only half as many times as in test 1, when a cow could see feed entering the compartment almost as soon as she started to drink. However, the cows drank more at a time in test 3 than in test 1.

The setup in test 3 would naturally reduce wear-and-tear on the equipment. In test 2, using the partition without the reservoir somewhat reduced the number of times the feeder started each day.

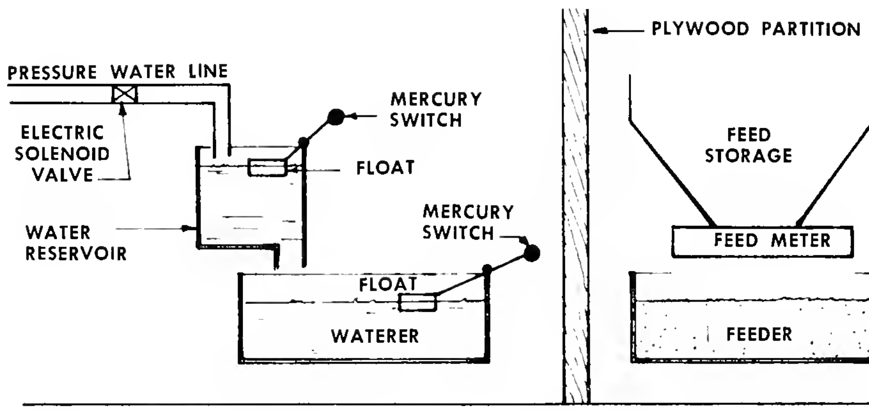
Plans for the future

Further tests are being planned with two groups of cattle, 10 in each group. One group will be fed with the new feeder for a period of time while the other group will be fed conventionally. Periods of conventional and of experimental feeding will be alternated for each group until adequate comparisons can be made.

If these tests give as favorable results as the ones already conducted, we can say that the water-controlled feeder has much potential. It can be a simple, low-cost unit that provides feed and water for a group of cattle, but that still meets the requirements of the individual cow. This method of feeding can reduce labor requirements to a minimum and increase labor efficiency.



Equipment for Test 1. As the cow drinks, the float in the waterer lowers, activating the mercury switch. This opens the solenoid valve, allowing water to flow, and at the same time starts the grain meter that delivers the ration. (Fig. 2)



Equipment for Test 3. When the float in the waterer is lowered, it activates a mercury switch which opens the solenoid valve, allowing water to enter the reservoir. As the float rises in the reservoir, its mercury switch operates the feed meter, which fills the feeder. A partition between the waterer and feeder keeps the cow from seeing the feed while she is drinking. (Fig. 3)

Results of Tests on Each of Three Cows

Test	Av. daily milk production, lb.	Av. daily consumption Water, gal.	Av. daily consumption Grain, lb.	Feeder starts daily	Lb. milk per lb. grain	Lb. water per lb. grain	Av. temp. 7 p.m., °F.
	COW NO. 1612 (Sept. 18-Oct. 13)						
1	63.0	24.7	18.7	54	3.37	11.0	59
2	58.9	24.3	18.4	56	3.20	11.0	62
3	66.5	28.6	21.6	32	3.10	11.0	58
	COW NO. 1911 (Nov. 29-Dec. 17)						
1	45.1	18.4	14.8	40	3.04	10.3	48
2	49.7	16.3	13.1	36	3.79	10.3	23
3	53.0	19.6	15.8	22	3.36	10.3	32
	COW NO. 1750 (Oct. 27-Nov. 20)						
1	44.9	22.7	22.0	49	2.05	8.55	44
2	42.4	18.0	17.4	43	2.45	8.60	45
3	42.9	21.0	20.2	22	1.96	8.60	44

Haylage compared with hay in steer rations

A. L. NEUMANN

HAYLAGE is a term applied to a roughage feed harvested from the straight alfalfa or the legume-grass seedings used in Illinois crop rotations. It is intermediate in moisture content — that is, it is too wet for storage as hay but is drier than silage. Moisture levels of 30 to 50 percent are preferred.

Forage stored for haylage, like that stored for silage, undergoes fermentation. Spoilage losses are therefore excessive unless storage is in oxygen-free silos such as Harvestores or in very well-covered conventional silos in an excellent state of repair.

Steers receive four rations

The feeding value of haylage for steers was tested during the winter of 1961-62. Forty yearling Hereford steers were fed from a starting weight of about 700 pounds to a final slaughter weight of about 1,100 pounds. The steers were divided into four lots, 10 in a lot, and fed as follows:

Lot 6. Full feed of haylage, high-moisture corn, and a protein supplement of soybean meal.

Lot 9. Full feed of hay, corn, and soybean meal.

Lot 5. Haylage and corn without a supplement.

Lot 8. Haylage, with corn and supplement limited at first but with increasing amounts being fed per unit of body weight as the feeding period progressed.

The haylage and hay were both third-cutting alfalfa from one field. The haylage, stored in a Harvestore, contained only about 27 percent moisture so was a bit dry. It was of exceptional quality, however, analyzing 17 percent crude protein. The hay was of comparable quality and contained 14 percent moisture. Field-shelled, high-moisture corn was fed to all lots after being crimped upon daily removal from the Harvestore.

Each steer received 20,000 I.U. of preformed vitamin A daily, as well as a complete mineral mix fed free choice. Diethylstilbestrol was not used.

The 10 steers in each lot were slaughtered after the lot reached an average weight of about 1,100 pounds, and carcasses were evaluated.

Comparisons made

Feedlot results and carcass data are summarized in the table. In a comparison of haylage and hay (Lots 6 and 9), haylage proved more palatable, as indicated by a 29-percent greater intake of roughage. Haylage-fed steers gained 7 percent faster than those fed hay. Feed costs and carcass merit were comparable and very acceptable in both groups except for loin-eye area, which was generally poor in all lots.

Performance and Carcass Data of Steers on Four Rations

Item measured	Lot 6 Haylage, corn, supplement	Lot 9 Hay, corn, supplement	Lot 5 Haylage, corn	Lot 8 Haylage, ltd. corn and supplement
No. of steers	10	10	10	10
Days fed	154	154	154	182
Av. initial wt., lb.	693	692	696	690
Av. final wt., lb.	1,131	1,102	1,106	1,130
Av. daily gain, lb.	2.84	2.65	2.65	2.42
Daily consumption, lb.				
Haylage (85% DM basis)	7.52	.....	7.86	15.36
Hay (85% DM basis)		5.83		.....
Shelled corn (85% DM basis)	14.61	14.51	15.34	8.59
Soybean meal (50% C.P.)	1.50	1.49		0.70
Total (85% DM basis)	23.63	21.83	23.20	24.65
Daily feed per 100 lb. liveweight, lb.	2.59	2.43	2.57	2.71
Feed per lb. gain (85% DM basis), lb.	8.32	8.20	8.65	10.19
Feed cost[a] per cwt. gain, dol.	15.02	15.37	14.49	14.60
Av. dressing pct.	64.1	64.2	63.7	61.9
Av. cooler shrink, pct.	2.55	2.35	2.37	1.86
Av. quality grade[b]	19.9	19.4	18.8	18.6
Av. conformation grade	19.8	18.7	18.9	19.2
Overall grade	19.3	18.8	18.2	18.6
Av. fat thickness, in.	0.76	0.79	0.74	0.65
Av. loin-eye area, sq. in.	11.00	10.68	10.61	10.04
Loin-eye area per cwt. carcass, sq. in.	1.52	1.50	1.51	1.45
Yield group[c]	4.52	4.57	4.46	4.40
Yield of trimmed retail cuts, pct.	62.7	61.6	62.8	61.0

[a] Feed prices used: Haylage and hay, $20 per ton of 85 percent dry matter forage; corn, $40 per ton of 85 percent dry matter corn; soybean meal, $80 per ton. Vitamin A and mineral costs are not included nor is any attempt made to adjust for differences in harvesting or storage costs.
[b] Good plus = 18; Low choice = 19.
[c] The lower the number, the better the yield (scale ranges from 1 to 6).

Steers on supplement (Lot 6) gained 7 percent faster than those without supplement (Lot 5), but gains were 3.5 percent more costly. Carcasses were similar in all respects.

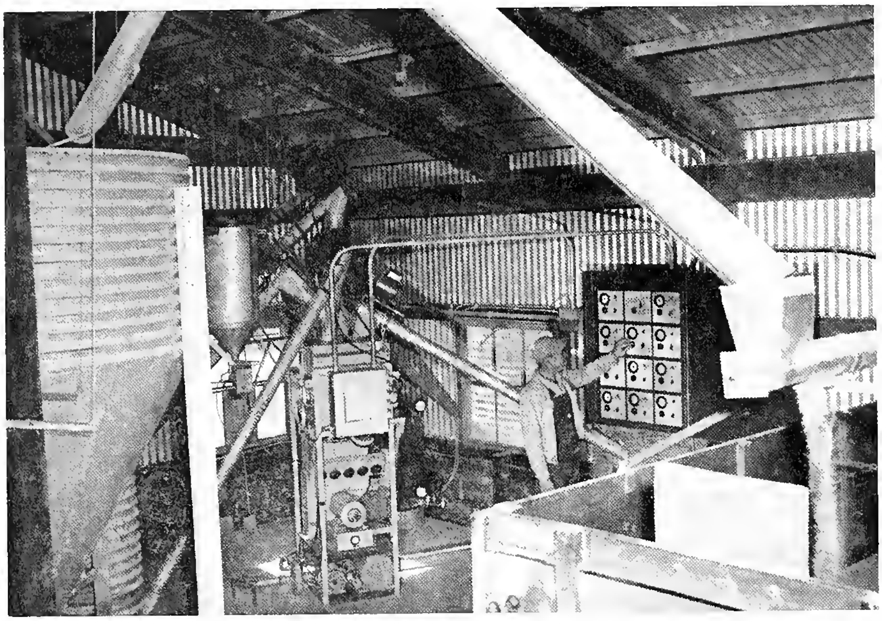
Full-feeding corn and supplement along with haylage was more successful than limited feeding (Lots 6 and 8). Gains were 17 percent faster for the full-fed steers. Costs were lowered slightly by limited feeding, but dressing percentage was significantly reduced. Although fat thickness was reduced a little, the yield of trimmed cuts was not improved.

According to these tests, alfalfa haylage is more palatable than hay, it provides adequate protein for full-fed yearling steers, and it is a most acceptable roughage. Limited feeding of corn and protein supplement with a full feed of haylage was not satisfactory.

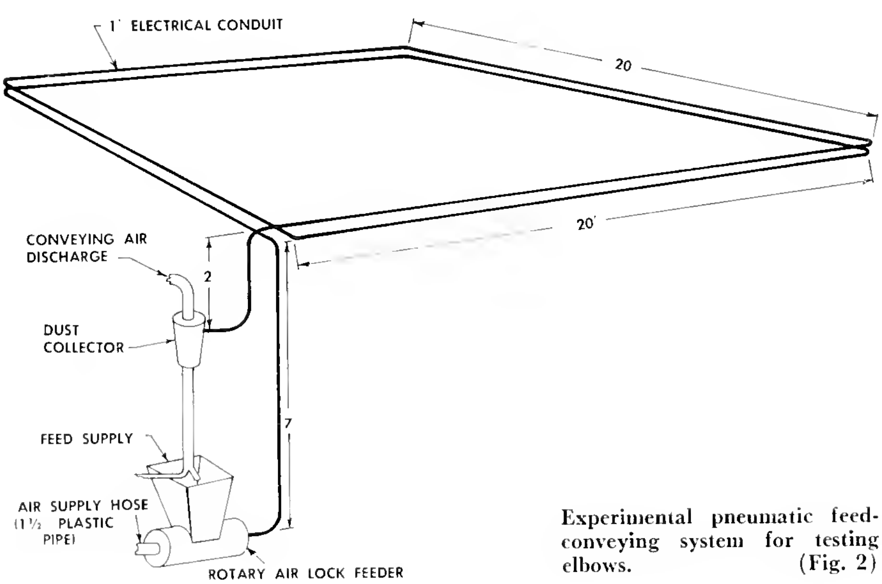
A. L. Neumann is Professor of Animal Science.

MEDIUM-PRESSURE PNEUMATIC FEED CONVEYOR

H. H. KLUETER, H. B. PUCKETT, and E. F. OLVER



This automatic feed-preparation and distribution system mixes as many as four out of seven possible ingredients to form a complete ration. As the feed is ground, a medium-pressure pneumatic conveyor transports it to any one of four discharge points. The distribution control panel is shown at the right. The power control panel is on the mill. (Fig. 1)



Experimental pneumatic feed-conveying system for testing elbows. (Fig. 2)

H. H. Klueter, formerly Instructor of Agricultural Engineering, is now Agricultural Engineer, Farm Electrification Research Branch, U. S. Department of Agriculture, Beltsville, Md. H. B. Puckett is Agricultural Engineer, Farm Electrification Research Branch, U. S. Department of Agriculture, Urbana. E. F. Olver is Associate Professor of Agricultural Engineering.

Farmstead mechanization has increased dramatically in recent years. Large broiler enterprises, the confinement of hogs, and the increased size of beef and dairy farms all point to an even greater need for mechanization.

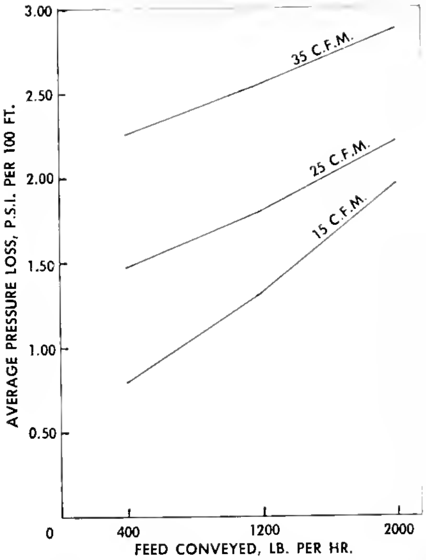
Feed handling is an integral part of the mechanization process. Trucks, wagons, blowers, augers, elevators, and drag chains are now widely used for moving feed. A new method that has shown promise is medium-pressure pneumatic conveying.

This method has several advantages: The 1-inch thin-wall metal tubing or rigid metal pipe is easy to install. Feed can be easily distributed to various points. The small air requirement results in a high feed-to-air ratio (12:1 or greater) with a minimum of dust. And it's easy to expand the system.

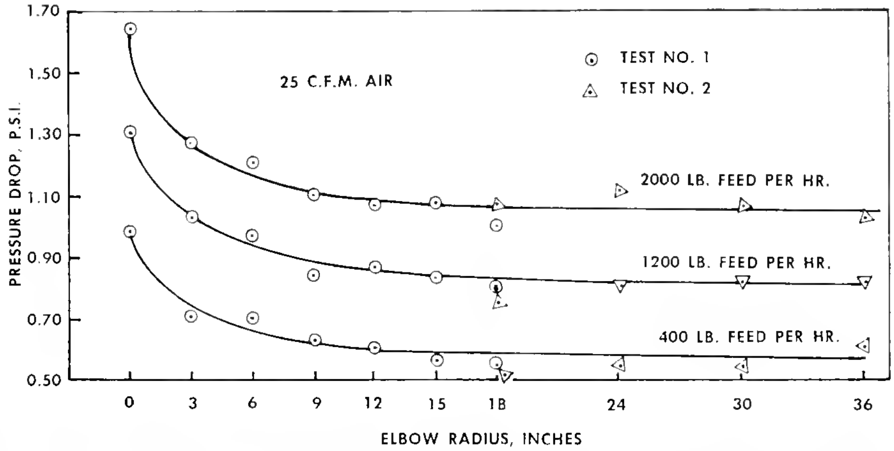
One disadvantage is the relatively high cost of the components. Another is that feed is delivered to only one location at a time. Special valving is required for discharging feed to more than one point.

Work at the University of Illinois has provided engineering data necessary for installing and integrating the various components of a pneumatic system. A successful system (Fig. 1) has been in operation since June, 1959, on a farm equipped to handle a potential flock of 30,000 turkeys (see Illinois Research, Summer, 1960). The overall system brings various ingredients from storage; meters, blends, and grinds them; and pneumatically conveys the mixed ground feed to one of four locations. Feed flow is 1,200 pounds per hour through a 1-inch pipe, maximum distance is 400 feet, and air pressure is about 7¼ pounds per square inch.

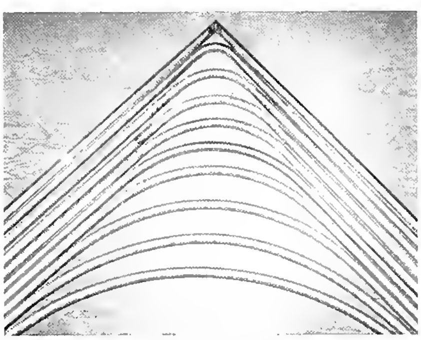
In the meantime research on such a system is continuing at the University. A schematic design of the test unit is shown in Figure 2.



Pressure loss versus feed conveyed for three air flows per 100 feet of 1-inch pipe. (Fig. 3)



Pressure drop versus elbow radius for three feed rates at 25 cubic feet of air a minute in two series of tests. (Fig. 5)



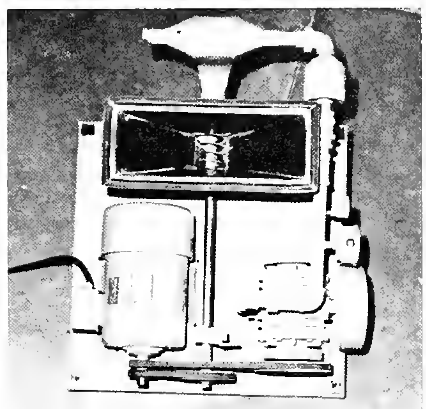
Three groups of seven elbows were tested. Test 1 included a mitered elbow and elbows with radii of 3, 6, 9, 12, 15, and 18 inches. Test 2 had three 6-inch elbows and one each of 18, 24, 30, and 36 inches. One 6-inch elbow was flattened ¼ inch through the bend; one was flattened ⅛ inch; one was left round. Test 3 included two 6-inch, three 9-inch, and two 12-inch elbows. One elbow of each radius was left round and one was flattened ¼ inch. The third 9-inch elbow was flattened ⅛ inch. (Fig. 4)

Pressure losses

Pressure drop per 100 feet of 1-inch pipe was studied for various combinations of air and feed flow rates. Some of the results are shown in Figure 3.

Effects of various elbows on pressure loss were also measured. A mitered elbow was tested, plus elbows with radii of 3, 6, 9, 12, 15, 18, 24, 30, and 36 inches (Fig. 4). As shown in Figure 5, pressure drop decreased gradually as elbow radius was increased to 18 inches. There was little difference in pressure drop between the 9-inch elbow and either the 6-inch or the 12-inch elbow. In a pneumatic conveying system using 1-inch pipe, the 9-inch elbow, flattened ¼ inch, was found to be best.

An increase in air flow or in feed flow will increase pressure drop linearly in the system. The equivalent length of pipe for 6-, 9-, and 12-inch elbows is 8 to 15 feet when conveying 400 pounds of feed per hour, and 25 to 35 feet when conveying 2,000 pounds of feed per hour.



The package unit for conveying feed consists of a hopper-auger injector assembly, a compressor, and a power unit. The compressor draws air through the dust filter (right) and forces it over the auger feed injector (top). Feed from the hopper is forced through the injector and into the air stream. (Fig. 6)

The total pressure at the compressor is the sum total of all pressure drops in the piping system. Following is the best estimate of pressure drop for a medium-pressure conveying system, assuming a 1-inch pipe, a feed flow of 1,000 to 1,200 pounds per hour, and an air flow of 25 cubic feet per minute:

	Loss, p.s.i.
100 feet of system length	1.5 — 2.0
90-degree 7-inch radius elbow*	0.4 — 0.5
10 feet of vertical lift	0.3
Feeder valve and entrance losses	1.5
Flow diverter valve, straight side	0.3
Flow diverter valve, branch side	0.6

* Standard conduit benders bend 1-inch conduit to a radius of not less than 6 inches nor more than 11 inches; the 7-inch radius is common for 1-inch thin-wall steel tubing and is used in this table.

Auger feed injector

One recent development in our research is an auger feed injector (Fig. 6) for forcing the mixed ground feed into the air stream. Originally, a star wheel feeder was used for this purpose, but it was costly and, with wear, it allowed too much air loss. The new injector has a high-speed, small-diameter auger with a tapered discharge section. When feed fills this tapered section, it forms a seal that prevents air loss.

Several pneumatic conveying systems with the auger feed injector are operating with much satisfaction on Illinois farms. We expect a great increase in the use of these injectors when components become commercially available.

LARGE-SCALE FARMS IN ILLINOIS

FRANKLIN J. REISS

Large-scale farms account for only a small part of Illinois agriculture. Just 553 Illinois farms fell into the large-scale category in 1959, according to figures recently released by the Bureau of the Census. That same year, 19,979 farms and ranches in the country as a whole were classified as large-scale. As defined by the Bureau, large-scale farms are those that sell at least $100,000 worth of farm products in a year.

The 553 Illinois farms represented 0.4 percent of the 123,328 commercial farms in the state and included 1.5 percent of the farmland. But they contributed 5.9 percent of the total value of farm products sold from commercial farms in Illinois.

Corn, hog farms not large-scale

Although most large-scale farms are highly specialized, they are far from monopolizing such staples as corn, hogs, and dairy products. They produced only 1.8 percent of the corn harvested for grain, 1.0 percent of the dairy products, and 2.2 percent of the hogs and pigs sold.

On the other hand, they produced 6.3 percent of the fruit and nuts, 13.2 percent of all cattle and calves sold, 27.7 percent of the vegetables, and 49.3 percent of the forest products and horticultural specialties.

A similar concentration appears among large-scale farms and ranches in the United States as a whole. They accounted for 16.9 percent of all products sold from commercial farms; 25.1 percent of the rice; 24.4 percent of the cotton; 32.1 percent of fruits and nuts; 29.6 percent of the Irish potatoes; 47.4 percent of all vegetables; 17.3 percent of poultry products; 23.7 percent of all cattle and calves; 16.8 percent of sheep and lambs; and 40.3 percent of forest products and horticultural specialty crops. But they accounted for only 1.8 percent of corn sold, 7.6 percent of dairy products, 2.0 percent of hogs and pigs sold, and 2.5 percent of all tobacco.

Franklin J. Reiss is Professor of Farm Management and Land Economics.

Acreage not always large

Some farmers can market $100,000 worth of products from small acreages. Large broiler enterprises, cattle feeding lots, and certain intensive horticultural enterprises, for example, do not require a large amount of land.

Of the 553 large-scale Illinois farms, one out of five was less than 260 acres in size (Table 1). Three out of five were in the 260- to 999-acre range. Average size was 774 acres.

Part-owners predominate

There were fewer full-tenants and full-owners and more part-owners among the large-scale farms in Illinois than among all commercial farms. Following are the percentages for ownership and tenancy:

	Large-scale	All farms
Fully owned	27.8	31.7
Entirely rented	26.4	39.5
Partly owned, partly rented	36.0	28.5
Operated by managers	9.8	0.3

Farms classified as fully owned were not necessarily debt-free. Rented farms were not necessarily rented from one owner. For partly owned farms, the proportions owned and rented are not known. Farms operated by managers included those controlled by corporations, institutions, and governmental agencies.

Large consumers

Large-scale farms are not only large producers, they are also large consumers and users of capital goods. On the 553 Illinois farms, the average per-farm expenditure for gasoline and other petroleum fuel and oil in 1959 was $3,668. These farms used 50 tons of commercial fertilizers per farm, and 77 tons of lime or liming materials. They hired 5.2 regular workers per farm.

On the other hand, their expenditures were well in line with their land resources. With 1.5 percent of the commercial farmland, they accounted for 1.6 percent of the lime, 2.3 percent of the commercial fertilizers, and 2.1 percent of the gasoline and oil used by all commercial farms. Similarly, they had only 1.1 percent of the tractors, 1.5 percent of the motor trucks, 0.7 percent of the corn pickers, and 0.5 percent of the grain combines on all commercial farms.

Farm record data

Through farm records kept by cooperating farmers in the Illinois Farm Bureau Farm Management Service, we can get a fairly complete picture of some large-scale farms. Examining the farm records for 1962, we found 174 farms whose gross sales amounted to $100,000 or more. Of these farms, 59 percent were cattle farms; 21 percent, hog farms; 2 percent, mixed livestock farms; 3 percent, poultry or dairy farms; and 15 percent, grain or crop specialty farms.

The predominance of cattle-feeding farms in our sample points up the problem of using gross sales as the criterion for large-scale farms. True, the value of farm products sold is

Table 1. — Distribution of Large-Scale Farms and of all Illinois Commercial Farms Among Seven Acre-Size Groups[a]

Acres per farm	Large-scale farms U. S.	Large-scale farms Ill.	All commercial farms in Ill.
	pct.	*pct.*	*pct.*
Under 100	13.0	11.7	14.8
100 to 179	4.9	2.9	28.7
180 to 259	4.7	5.1	24.7
260 to 499	12.2	28.0	26.3
500 to 999	17.1	30.9	5.0
1,000 to 1,999	17.9	16.3	.4
2,000 or more	30.1	5.1	.1

[a] Census of Agriculture, 1959.

$100,000 or more on these farms. The volume of farm production, however, is likely to be much smaller because at least half of the value of fat cattle sold may be due to the value already present in feeder stock brought onto the farm. Furthermore, part of the value added on the farm may be due to purchased feed.

In the records of the 174 farms, we therefore adjusted gross sales for value of purchased livestock and feed. Additional adjustments were made for changes in inventories. Figured this way, total farm production was less than $75,000 on most of the cattle farms (Table 2).

Some characteristics of the farms

Nearly half, or 48 percent, of the 174 large-scale, record-keeping farms ranged from 500 to 999 acres in size. The size distribution of the other 52 percent was as follows: 1 percent, under 180 acres; 6 percent, 180 to 259 acres; 13 percent, 260 to 339 acres; 21 percent, 340 to 499 acres; 11 percent, 1,000 to 1,999 acres. The average size of the record-keeping farms was 624 acres, as compared with 774 acres for the 553 Census farms in 1959.

Tenure distribution was different on the record-keeping farms than on the Census farms. In our sample, 15 percent of the farms were either owner-operated or manager-operated, 49 percent were operated by part-owners, and 36 percent by tenants. The Census reported percentages of 37.6, 36.0, and 26.4 respectively. The operator's ownership interest in the total investment on the record-keeping farms was 37 percent. The indebtedness against this interest is not known.

The average hired labor input was 21.7 months per farm, or an equivalent of 1.8 full-time men (Table 2). This compares with the average of 5.2 regular hired workers (employed 150 days or more) reported by the Census for the 553 large-scale farms in 1959.

Table 2. — Some Characteristics of Large-Scale Farms Among Record-Keeping Farms in the Illinois Farm Bureau Farm Management Service, 1962

Item	All large-scale farms	Under $75,000 total production[a]		$75,000 or more total production[a]	
		Under 700 acres	700 acres or larger	Under 700 acres	700 acres or larger
Number of farms	174	94	7	20	53
Average size of farm	624	420	822	504	1,006
Acres in:					
Corn, soybeans, corn silage	363	238	315	315	611
Feed-grain diversion	37	22	53	24	65
Canning and vegetable crops	4	3	7	2	6
Other crops	70	47	64	56	116
Hay and pasture	77	60	211	66	92
Total acres tillable	551	370	650	463	890
Number of:					
Litters of pigs	82	69	106	114	90
Milk cows	1.2	1.1	...	4.7	0.1
Cwt. of beef produced	1,531	1,421	1,653	2,109	1,492
Months of labor:					
Operator	11.4	11.5	11.9	11.4	11.2
Unpaid family	5.1	3.1	8.7	4.6	8.3
Hired	21.7	14.4	22.9	25.9	33.0
Total months	38.2	29.0	43.5	41.9	52.5
Total investment in:					
Feed, grain, livestock	$ 89,484	$ 75,616	$ 83,309	$115,181	$105,200
Machinery and equipment	55,891	46,319	49,217	71,526	67,850
Land and buildings	217,851	144,219	222,547	183,752	360,690
Total investment	$363,226	$266,154	$355,073	$370,459	$533,740
Percent owned by operator	37	39	50	34	35
Total sales of:					
Livestock	$120,592	$120,876	$116,379	$158,623	$106,294
Livestock products	1,061	1,206	298	2,922	202
All crops	24,761	12,503	13,560	13,414	52,264
Total per farm	$146,414	$134,585	$130,237	$174,959	$158,760
Livestock and feed purchased	$ 87,138	$ 90,598	$ 84,616	$108,370	$ 73,321
Value, total farm production[a]	73,239	52,868	58,085	84,989	106,935
Returns to operator's labor and management	14,509	10,951	453	20,487	20,420
Gas, oil, fuel purchased	2,775	2,031	3,520	2,712	4,021
All fertilizers purchased	4,820	3,475	4,707	4,517	7,335

[a] This is the amount of gross production or value added on the farm. All of these farms had gross sales of $100,000 or more in 1962, but when gross sales were adjusted for changes in inventory and for purchases of feed and livestock, the value actually produced on most of the farms was considerably below $100,000.

Returns to the operator

A large-scale operation alone was not enough to guarantee high returns for the 174 operators (Table 2). In 1962 the average operator received a rather modest $14,509 for running a business with a total investment of more than $360,000 and gross sales of nearly $150,000. The seven operators with 700 acres or more but with total production under $75,000, received very low returns for their labor and management. This was due partly to less than optimum land use, partly to unfavorable spreads between feeder-cattle and fat-cattle prices.

What of the future?

Large-scale farming, as defined by the Census, is still a relatively small part of Illinois agriculture. It will probably increase, however, both in Illinois and elsewhere.

We can particularly expect more large-scale farming in those lines of production where it is already most prevalent. These include enterprises in which (1) scale economies are most likely to be achieved; (2) technological development has permitted greater control of production; (3) specialization permits marketing advantages and management economies; (4) cheap, unskilled (frequently migrant) labor can be employed; or (5) capital input is high in relation to labor input.

Evaluation of chemicals for control of SOIL-BORNE ROOT ROT FUNGI

MANSON B. LINN

ALMOST ALL field crops, vegetables, trees, and ornamentals can be attacked by root rot fungi in the soil. Infected plants become stunted and yellow, wilt, and often die.

There are many species of these fungi. Some are quite specific in their host range; *Diplodia zeae,* for example, attacks only corn. Other fungi, such as *Rhizoctonia solani,* may attack many kinds of plants. Certain fungi may persist in the soil indefinitely while others live only one or two years.

Control of the root rot fungi has been approached from several angles. The measures that have been tried include rotation with non-susceptible crops, elimination of weed hosts, use of resistant varieties, and pre-planting fumigation of the soil with eradicative, volatile chemicals such as chloropicrin. These practices have been successful in some instances. None of them, however, alone or in combination, is enough to eliminate all root rot fungi.

A new approach to the problem is the broadcast or band application of non-volatile fungicides that are insoluble in water. They are distributed as granules or sprayed in a water suspension on the soil surface and then mixed with the soil at the time of seeding.

Laboratory and greenhouse tests

A number of such fungicides have been tested in the Plant Pathology laboratory and greenhouse. A few basic methods or variations of these methods have been used. The chemical and fungus can be placed together on culture media in test tubes or petri dishes (Fig. 1). The growth, if any, of the fungus is measured and compared with growth after use of a standard fungicide. This method is useful in determining the relative effectiveness of different concentrations of a chemical against several soil fungi. The test fungus can also be grown in a mixture of soil and nutrients in paper "jelly" cups. Different concentrations of the fungicide are added and the surface growth, if any, of the fungus is determined.

A soil tube developed in this laboratory by Dr. Archie Latham allows us to test two or more species of fungi at the same time. The tube is in lap-jointed sections, permitting insertion of the test fungi at different levels in the column (Figs. 2 and 3).

The fungicide can be mixed with water and poured on top of the column, or it can be mixed with the soil before water is added to the column. Effectiveness of a fungicide is determined after recovery of the fungus and plating on suitable culture media. Other measurements can also be made: the depth to which the fungicide has penetrated the soil; fungitoxicity of the chemical after it has percolated through the soil; diffusion of the fungicide in different soil types; and the rate at which the fungicide breaks down in the soil.

In the greenhouse, susceptible seedlings can be grown in soil infested with root-rot fungi, and treated with the test fungicide. The extent of root rot control, concentrations of fungicides harmful to plant growth, and the possibility of root absorption and translocation can then be determined. Effect of the fungicide on nodule-forming bacteria and other beneficial soil microorganisms can also be ascertained.

Field-testing presents problems

It might appear that after a well-formulated, wide-spectrum fungicide has been found, testing in the field would present no serious problem. This, however, is not true. Whether a fungicide is impregnated on granules or is in a water suspension, it must be accurately distributed on the soil surface and thoroughly mixed with the soil to the desired depth, preferably in a band application.

Although root rot fungi may be in the experimental area, they may not cause trouble unless soil temperature and moisture are favorable. For example, the four principal root rot fungi of peas have optimum temperatures for growth ranging from about 65° to 82° F. Thus, in cool growing seasons only one or two pathogens may cause appreciable damage, while in warmer seasons the other pathogens may predominate.

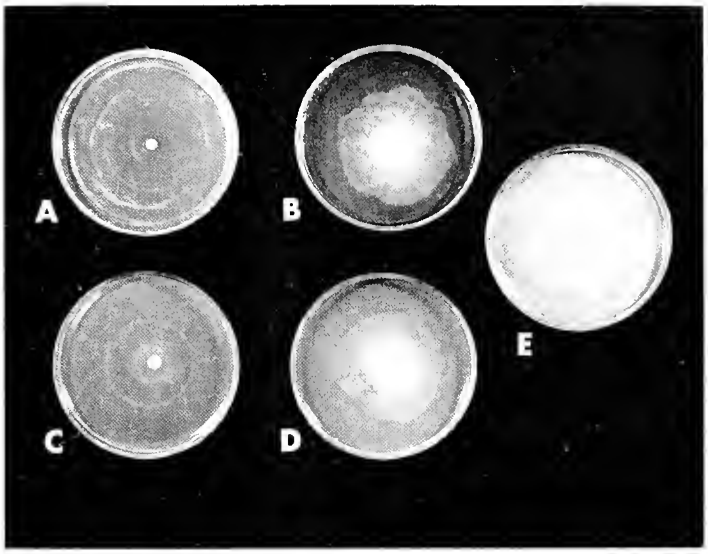
White rot of onion sets

In 1958 field tests were undertaken to find a control for white rot of onion sets, which was causing heavy losses in Cook county. The fungus produces many tiny black sclerotia or resting bodies on the decaying onion bulb. These sclerotia enable the fungus to overwinter in the soil. When an onion root touches one of these sclerotia, the fungus invades the root, killing the plant.

Because of the serious losses, field tests had to begin before laboratory tests could be completed. Since 1958, 18 fungicides have been evaluated in Cook county fields.

The fungicides were broadcast, either on granules or as suspensions in water, and were mixed with the soil to a depth of 3 inches. Disking, harrowing, and slow-speed rotovation were used for the mixing. Only rotovation gave enough control to permit selection of the most effective

Monson B. Linn is Professor of Plant Pathology.

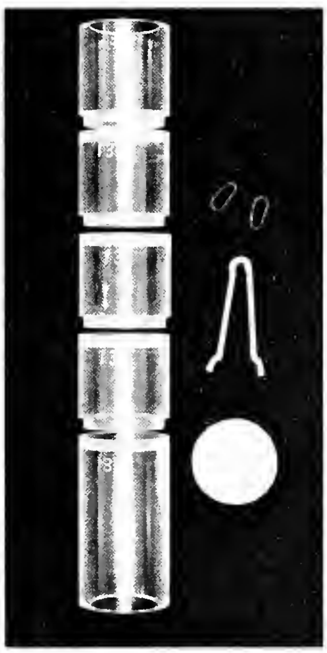


owth of onion white t fungus on potato-xtrose agar to which s been added Mylone 10 p.p.m. (A) and 1).m. (B), and thiram 10 p.p.m. (C) and 1).m. (D). No fungicide ıs added to plate E. ɔte that 10 p.p.m. of ıram suppressed fun-s growth almost com-ɜtely. (Fig. 1)

Yields of Onion Sets in White-Rot Infested Soil After Treatment With Two Chemicals, 1963

Treatment	Mean wt. per A., lb. Over-runs, 15/16"+	Sets 3/8"-15/16"	Total	Pct. sets
Thiram	5,445	16,088a*	21,533	74.7
Botran	6,994	12,676a	19,670	64.4
None	8,959	8,451b	17,410	48.5

* Figures followed by the same letter are not significantly different at the 5-percent level.



Soil column disassembled, showing plastic screen and retaining clip used at bottom to retain soil. (Fig. 2)

Placing disks of test fungi at the 3-inch depth in a soil column before treatment of the soil with a fungicide. Joints are sealed with plastic electrical tape. (Fig. 3)

fungicides. Rather poor correlation was found between the performance of some of the fungicides in soil column experiments and performance in the field.

Two fungicides that showed promise in these evaluative tests were Botran (2:6-dichloro-4-nitroaniline) and thiram, or bis(dimethylthiocarbamyl) disulfide. In April of 1963 they were applied to a field where onions had been severely damaged by white rot in 1961 and 1962. The fungicides were applied as 5-percent formulations on granules in a 4-inch band between the seed outlet and coverer of a 6-gang Planet Jr. seeder.

Two rows were treated with Botran at 15 pounds active per acre, two rows with thiram at 55 pounds active, and two rows were left untreated. The experiment was replicated 6 times. Sets were harvested on August 8, and after drying were graded on September 26 (see table).

Neither fungicide completely controlled white rot. However, the thiram-treated plots yielded almost twice as many sets as the untreated plots. Both fungicides gave good enough results that, if approved by the FDA for this use, they can be used as a "stop-gap" control until a better method can be devised.

Root rot of peas and beans

Field experiments for control of root rot diseases of peas and snap beans have given very erratic results. This inconsistency is believed to be due, in large part, to incomplete mixing of the fungicides with the soil. At present, the Departments of Agricultural Engineering and Plant Pathology are cooperating with certain fungicide manufacturers in developing a unitized fungicide applicator, soil mixer, and precision planter. This equipment is being devised primarily for the use of research workers in the field evaluation of fungicides rather than for farmers and food processing companies.

More information sought

Research is being continued to learn more about the specificity of fungicides for root rot pathogens of canning and field crops, and the speed with which these compounds lose their effectiveness in the soil. Additional information is also needed on the performance of fungicides in various soil types.

BLOOD GROUPING OF PIGS

Genes determining blood type serve as markers in selection program

B. A. RASMUSEN

A MORE EFFICIENT swine-breeding program may develop from present research on swine blood groups.

Typing of animals' blood has grown out of research on human blood types. For over 60 years it has been known that humans may be of blood groups A, B, AB, or O, and that the wrong blood in a transfusion can cause death. The desire to save human lives has led to many studies of the differences in human blood.

Tests to determine differences are based on the reaction of the red blood cell (the *antigen*) with globulin in the blood serum (the *antibody*). Red blood cells from one individual are washed in a salt solution, and a drop of the suspended cells is then mixed with the diluted serum from another individual. If a reaction takes place between the surface of the red blood cells and the serum antibody, as evidenced by a clumping (agglutination) of the cells, the two individuals belong to different blood groups.

For example, a person of group A has A red cells but does not have anti-A antibody in his blood serum. He does have antibody against B cells. Similarly, a person with group B blood lacks anti-B antibody, but has anti-A antibody. Hence, when A blood cells are mixed with B serum, they are agglutinated by the anti-A antibody in the serum.

Early studies with animals

In early studies of animal blood groups, attempts were made to relate animal groups to those of man. It was found, for example, that some pigs have red blood cells which are agglutinated by anti-A antibody. These pigs are classified as group A, just as some humans are. Until a decade ago, A versus non-A was the only blood-group difference in pigs for which the genetic basis was known.

In the meantime, pigs of superior productivity were being developed, but little was being learned about the individual genes causing differences among pigs. The effects of genes for coat color were analyzed, as were the effects of genes for a number of undesirable traits, such as brain hernia, congenital paralysis, and bent legs. These genes, however, are not very satisfactory to study in breeding experiments. They are not always readily identified, they may be influenced by environment, and genes for undesirable traits are expensive to maintain in an experimental herd.

Complexity becomes apparent

A little over 20 years ago the discovery of Rh incompatibility in humans led to an increased interest in human blood groups, and many modifications of the simple agglutination test were developed. It soon became apparent that human bloods could be classified into thousands of different types.

At about the same time, detailed studies of blood groups in cattle and chickens were begun. It was found that blood types in these animals are fully as complex as human types. Blood groups in cattle have been used frequently to decide cases of disputed parentage. They may also be used to exclude the possibility that calves are one-egg (identical) twins or that a heifer calf born co-twin to a bull is a freemartin. Blood

B. A. Rasmusen, Associate Professor of Animal Genetics, draws blood sample from the jugular vein of a hog.

groups in chickens have been used in poultry breeding research.

During the last decade a number of North American and European institutions have begun research on blood groups in pigs. Many different blood types have been found in pigs, just as in man, cattle, sheep, and chickens. It appears that the complexity of blood groups in any species is directly related to the amount of research which has been done on them.

At least 11 different genes in pigs determine red-blood-cell antigens. These genes form the basis for 11 genetic systems of blood groups. Each gene can occur in at least two forms, so that a large number of blood groups can now be used for studying genetic differences.

These 11 genes are particularly useful as genetic markers: The red-blood-cell antigens which they determine are influenced very little by environment; none of them have marked undesirable effects; and their distribution can be accurately determined from generation to generation in breeding experiments.

Positive and negative agglutination tests are shown in the two tubes being held above the rack. Clumping of cells in tube at left indicates a positive test. In tube at right, cells are evenly suspended, indicating a negative test. Tubes in rack show results of another kind of test (hemolysis). In tubes 1, 2, 3, and 5, red pigment (hemoglobin) has been released from the cells, showing a reaction between the red cells and the antibody. No reaction has occurred in the other tubes.

Test serums developed

A program is underway in the University's Animal Genetics Laboratory to develop appropriate test serums (reagents) for typing the blood of pigs. Antibodies reacting in the A-O system occur naturally in the blood serum of certain pigs, goats, sheep, and cattle. With few exceptions, however, reagents for other systems must be developed by repeatedly transfusing one pig with the red blood cells of another pig until the injected pig produces antibodies against the donor blood.

Reagents are now available in the Animal Genetics Laboratory to detect differences among antigens in 10 of the 11 known genetic systems. In addition, some test serums have been developed for antigens for which the genetic basis is not yet known. These reagents make it possible to distinguish more than a quarter of a million different blood types resulting from different combinations of blood-group genes.

Part of breeding project

Blood types are being determined for pigs as part of a breeding project in which selection will be practiced in some lines while other lines will be maintained as unselected control populations. It has been found that a particular red-blood-cell antigen is rarely unique to a breed, but rather that breeds differ in the frequencies of various antigens. The inheritance of blood groups is being studied, as is the rare appearance of new antigens. The blood groups in one system are rarely modified by genes of other systems. Occasional cases of gene interaction, however, may provide information as to how genes act, and these are given special attention.

Now that the blood groups of the original lines have been determined, it will be possible to observe changes in the frequency of each blood group. In the unselected control population, frequencies can be expected to remain constant unless they are influenced by natural selection beyond the control of the breeder. In the selected populations, some groups may be preferred over others by the nature of the selection program.

Some possible relationships

There are at least three different ways in which blood group genes may be related to traits such as litter size, growth rate, and backfat thickness:

1. The genes which are responsible for differences in blood types may also be responsible for other differences.

2. Blood group genes may be linked to genes influencing other characteristics. If the genetic linkage is a close one, this may make it possible to observe the nature of such linkage in a particular breeding line.

3. Every pig has two genes for each of the 11 known genetic systems of blood groups, one of the genes having been received from his sire and one from his dam. If he receives different forms of a gene from his parents (and is heterozygous or hybrid for that gene) the result may not be the same as if he gets the same form of the gene from each parent (and is homozygous). Therefore blood group genes may be useful in estimating hybrid vigor if this is related to heterozygous combinations of blood group genes. It is well known that in a number of plant and animal species hybrids have greater vigor than other individuals. Blood groups provide a means of determining degrees of heterozygosity within a line or breed of a species, as well as in line and breed crosses.

Fertility and litter size may be related to the degree of similarity between the blood group genes of the boar and those of the sow. And the degree of similarity between a sow and her piglets may influence the pigs' growth and development.

Incompatibilities in the human Rh system may have undesirable effects if a woman is Rh-negative and her baby is Rh-positive. This type of incompatibility is not known to occur naturally in pigs. However, it can be produced experimentally and it may exist naturally in a mild form that has some effect.

Significance of research

Since the effects of blood group genes on other traits, if any, are slight, a large number of animals will have to be studied over a number of generations to measure these effects. The blood grouping program at the University of Illinois is still in its infancy, but it is hoped that this research will eventually provide new tools for a selection program.

Visitors at World Flower Show in Chicago Learn About University Services

CARL F. MEES

BY THE TIME the 1963 World Flower Show in Chicago was over, about 50,000 visitors had stopped at the University of Illinois exhibit there and had requested 100,000 copies of University circulars and leaflets.

The Cooperative Extension Service of the University has had exhibits at the flower shows since 1959. The purpose has been to let Chicagoland people become better acquainted with the University and the services it renders. Many city people, for example, do not know until they attend the flower shows that publications about the home and its surroundings are available to them through the Extension Service.

The 1963 exhibit depicted the scope of the Extension Service, including activities in agriculture, home economics, and 4-H Club work. The Floriculture Division displayed many varieties of flowering shrubs, various lawn grasses, and weeds commonly found in lawns. The Horticulture Department in cooperation with the Illinois Department of Agriculture arranged a display showing the principal apple-growing areas in the state and the more common varieties of apples grown in Illinois.

The College of Agriculture had an informational booth explaining the college curricula. Also, since there is much interest in Chicago about the new University of Illinois campus to be built at Congress Circle, the model campus was exhibited.

University staff members, including specialists in Floriculture and Horticulture, manned the displays. Farm and home advisers and their assistants from 15 northeastern Illinois counties worked in the publications area.

The most popular publications were those on lawn care, including weed and disease control; pruning trees, shrubs, roses, and evergreens; and growing African violets and other house plants.

People who requested publications were asked to register. It was learned that 38 percent lived in Chicago and another 32 percent in Cook county outside Chicago. Among the other 30 percent were people from 64 other Illinois counties, 26 other states, and Canada, Mexico, and New Zealand.

Last October, questionnaires were sent to some of the people who had registered. Of the people who replied, 60 percent said they had read the publications completely and in some detail; 70 percent had filed them for future reference and 50 percent had referred to them since filing; 20 percent had used them in class reports or given them to friends and neighbors; only 5 percent had discarded them.

Carl F. Mees is Cook County Coordinator, Cooperative Extension Service.

W. R. Nelson (left) explains his new book, "Landscaping Your Home," to interested visitors.

Here visitors order copies of some of the other University publications displayed at the show.

These answers clearly indicated that people considered the publications valuable. In addition there were comments such as these:

"I'm very impressed with your service . . . had no idea it was available to city dwellers."

"This was one of the most helpful and constructive booths for the average person."

"We've thoroughly enjoyed the publications. I've said many times I'm glad I took a minute at the flower show to procure them."

The Cooperative Extension Service is now preparing another display for the 1964 World Flower Show, March 7–15. We're hoping that this year many more people will learn about the services of the University and the Extension Service.

STUDENTS' MOTIVES FOR ATTENDING COLLEGE

KARL GARDNER

AFTER some 30-odd years as a college student, agricultural extension worker, teacher, research worker, and administrator, I am still finding reasons which motivate youth to attend college. These stated motives often lack depth; still, they do help parents and young people to make the decision in favor of college. Some of the motives mentioned by students are:

Higher income. Most high school graduates become aware that a college graduate does make a higher salary. The 1960 Census showed average annual earnings of $9,206 for college graduates, $5,567 for high school graduates, and $3,906 for grade school graduates.

Security. Students also stress the word "security," since they have learned that the college graduate is far less likely to be thrown out of work than the unskilled, nonprofessional man. We cannot criticize this motive, but we hope that the student sees other motives of equally great importance.

Prestige or status. High school youth feel there is prestige in being a college graduate. They observe that college graduates often enjoy a high "status" in the community.

Parents insist. Many parents want very much to have their son or daughter go to college — often because they themselves did not have the opportunity to go. It is essential that parents do promote and encourage their children to consider college. It is not enough, however, for the parents to be interested in John attending school; John himself must want to go and want to badly enough to forego such things as immediate earnings after high school graduation or an early marriage.

Won a scholarship. Scholarships are valuable since they often tip the teetering youth off the fence and help him decide to go on for more education. Most scholarships are based not only upon a certain minimum academic ability, but also upon financial need. Even so, a typical scholarship is not going to pay a very large percentage of the total cost of going to college. A few scholarships, such as the Illinois agricultural, home economics, and legislative scholarships awarded annually in each county, are based entirely on academic merit.

"To become more thoroughly educated." This is certainly a most worthy objective even though it is usually somewhat indefinite in a youth's mind. If we include the purpose of "learning how to learn" and also acquiring the "urge to learn," then we have a more complete objective.

To get away from the farm. This objective is about as old as universities and is found in every country. Particularly where farm life has meant extremely hard work, no financial or other interest in the operation, and no time off for any recreation, then the urge to get off the farm has been great.

How to "get along on your own." Students often tell me that this is one of their main objectives. No doubt many students, for the first time in their lives, are faced with real responsibility when they leave home and go some distance to college. It does mature an individual to learn how to handle money and time in a responsible fashion.

To learn the social graces. We hear less and less of this motive as the years go by. It is probably true, however, that students do learn a great deal about the social graces on a university campus, and this can aid a man or a woman greatly.

Other good reasons

In addition to the above motives, we might add a few others.

A widened vision of occupational opportunities. University students become aware of a great many professional and vocational opportunities that they had never known about before going to college. This widens the horizon and enlarges the choice.

More interesting positions. A college graduate is more likely than others to become an administrator or a manager involved in planning projects and leading people. The problems to be solved and the hours of work involved do not necessarily result in an "easier" job, but the challenge makes the job enjoyable. Many of the positions open to high school and grade school graduates are likely to be monotonous.

Education for living as well as making a living. The extremely pragmatic person may overlook the value of learning to appreciate a wider variety of things as a result of attending college. Education should spark an interest in music, literature, art, and the theater. The better educated person also becomes more aware of the things about him and is better able to explain man and the forces of nature.

Education for service. Strangely enough, the educated person is trained not only for his own personal benefit, but for the advancement of man in general. He should be better able to serve his fellowman as a result of improved skills and capacities. The generosity with which he shares these with the less well-informed is, in a sense, another measure of his education.

Learning how to do the job better. Thomas Jefferson said aptly, "A man who qualifies himself well for his calling never fails of employment." Youth has to have something to sell to an employer. A strong back used to be enough, but today it is a keen and inquiring mind coupled with a technical or professional skill that brings rewards.

Karl Gardner is Associate Dean of the College of Agriculture.

RESEARCH IN BRIEF

Illinois and the Beginnings of Hybrid Corn

Many years of research lie behind the development of our modern corn hybrids. As early as 1877 Charles Darwin described the effects of self- and cross-fertilization in corn. That same year, W. J. Beal, Professor of Botany at Michigan State College, successfully demonstrated a method he had developed for hybridizing open-pollinated varieties. Not until much later, however, did G. H. Shull and E. M. East develop uniform inbreds through the use of repeated self-pollination.

The pre-history of hybrid corn would be incomplete without the contributions of the University of Illinois. G. W. McCluer and T. J. Hunt started inbreeding corn in 1889. McCluer, however, evidently failed to grasp the practical significance of the vigor he observed in crosses of mildly inbred strains. In Illinois Bulletin 21, published in 1892, he recommended selection within open-pollinated varieties as the practical method for farmers, ". . . though there does seem reason to believe that the crossing of such distinct and well fixed types will, for the time being at least, give larger corn and better yields."

In my opinion, McCluer was referring to the crossing of inbreds in this early statement, long before commercial hybrid corn was even dreamed of.

Work on corn selfing and crossing soon waned at Illinois, primarily because of interest in producing high-protein and high-oil varieties by mass selection. Although the records are missing, it is certain that inbreeding and crossing of lines continued in a small way under the direction of P. G. Holden and A. D. Shamel. Both men left Illinois, but not until E. M. East, a student and an analytical chemist in the Agronomy Department, had become acquainted with their work.

East went to the Connecticut Agricultural Experiment Station in 1905, taking with him a number of inbred lines, which he continued to inbreed and cross to produce hybrids. However, it remained for G. H. Shull, of Cold Spring Harbor, to clearly outline in 1908 a breeding program that led to eventual large-scale production of hybrid corn. — *D. E. Alexander*

Campers in Southern Illinois Are Questioned as to Their Preferences

Campers in the Glendale and Pounds Hollow areas of Shawnee National Forest were recently interviewed as to their preferences in such matters as campsite facilities, services, and atmosphere. The study was carried on by the Dixon Springs Experiment Station and the Cooperative Extension Service in cooperation with the Shawnee National Forest. The information will be used in helping farmers who are planning to develop commercial campsites on their farms.

Of the 158 families interviewed, 105 came from within 100 miles of the campsite. Most of the families — 122 — were from Illinois, while 21 were from Indiana. The heads of family were mostly in the 35-to-45 age range. Almost all the families (137) had children under 21, and the average family had four members.

Occupations of the men were classified according to the categories used by the Bureau of the Census. Professional and technical occupations headed the list with 42. The next largest group included 31 craftsmen and foremen. All but six of the families had none to two years of experience in camping.

When the campers were asked why they selected this particular campground, by far the most frequently mentioned reason was personal recommendation. This strengthens the belief that people select their leisure-time destinations by recommendations from friends, relatives, and co-workers.

A few queries were made as to the facilities wanted in campgrounds. Running water headed the list, but only 18 of the families mentioned hot showers. Nearness to water was one reason for liking a certain camping location, and privacy was another reason mentioned. This was the first year for the study, and it is hoped that next year another study can be made in more depth.— *Karl Munson*

Deterioration of Prepared Horseradish Studied to Find Ways of Prolonging Shelf Life

The deterioration of bottled prepared horseradish has been studied in the Food Science Department to explore possible ways of extending the shelf life of this condiment.

Prepared horseradish, a fresh food item containing chiefly grated horseradish, water, distilled vinegar, and salt, deteriorates noticeably several weeks after preparation, even when kept in tightly closed bottles at common refrigerator temperatures, 42° to 45° F. Loss in pungency, darkening, and an earthy odor denote this deterioration. To market horseradish successfully, the processor has to continually prepare a fresh supply from a stock of root held in cold storage.

The pungency of horseradish is due to an oil known as allyl isothiocyanate. When the roots are ground this oil is released from a glucoside, sinigrin, by an enzyme system known as myrosinase.

Storage temperature markedly influences the rate at which allyl isothiocyanate disappears from bottled prepared horseradish. After storage in tightly covered bottles for 3 weeks at 34°, 50°, and 75° F., horseradish samples retained 74.8, 51.4, and 37.1 percent of their original allyl isothiocyanate content. Samples that

were frozen immediately after bottling and kept at 0° F. for 6 months retained 91.9 percent of the allyl isothiocyanate.

Analysis by gas chromatography has shown that horseradish which has lost a high percentage of the pungent oil during storage contains allyl nitrile, a substance not detected in freshly prepared horseradish. This suggests that loss of pungency is due to a breakdown of allyl isothiocyanate in a reaction which yields sulfur and allyl nitrile. Allyl nitrile has neither the pungent odor of allyl isothiocyanate nor the earthy odor of deteriorated horseradish. The substances contributing to the earthy odor remain to be found.

Cream style horseradish has ingredients similar to those of prepared or plain horseradish, plus about 2 percent butterfat as sweet cream. At 45° F., cream style horseradish contained 87 percent of the original pungent oil after 4 weeks as opposed to only 48 percent for plain horseradish. The butterfat, in a colloidal dispersion such as cream, evidently absorbs the pungent oil, retarding its breakdown.

A limited sampling of types of horseradish grown near East St. Louis was made by the Horticulture Department. Sass, a Bohemian type of horseradish, contained 1.39 percent allyl isothiocyanate on a dry weight basis, while the common and Swiss types contained 1.11 and 1.04 percent, respectively.

Horseradish samples from each of these root types were prepared in the food processing laboratory and were analyzed for pungent oil content immediately after bottling.

The allyl isothiocyanate contents based on the dry weight of root were less than those mentioned above, probably because the volatile oil was lost during grinding and bottling. Sass horseradish contained 1.05 percent allyl isothiocyanate while common and Swiss yielded 0.913 and 0.912 percent, respectively. Processors find that Sass horseradish has comparatively poor keeping quality in cold storage and is also likely to have hollow discolored centers.

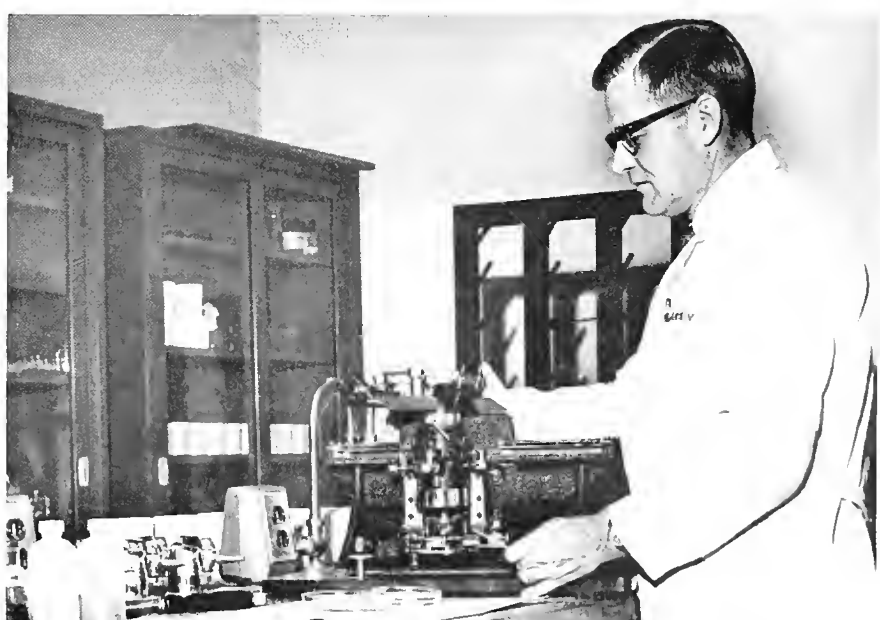
The darkening associated with deterioration was investigated with a tristimulus color meter, and was described as a decrease in whiteness and an increase in yellowness. Like pungency loss, darkening is influenced by storage temperature. Samples held at 50° and 75° F. darkened more in 1 week of storage than did samples held for 3 weeks at 34° F. Sulfite addition and blanching inhibited darkening, suggesting that color change may be due to enzyme activity of the root. — *F. E. Weber and A. I. Nelson*

Changes in Tree Environment May Influence the Anatomical Characteristics of Wood

The day when foresters, working with wood scientists, can grow trees producing wood with specific properties for specific uses, is probably not in the immediate future. Today there is only the trend in this direction.

In recent years wood scientists and foresters have become specially interested in the way that environmental conditions of forest trees influence the properties of wood from these trees. It has been observed that wood-quality indices, such as specific gravity or density, percentage of latewood in the annual ring, cell length, cross-sectional cell dimensions, and ray volume, apparently are related to tree environment and can be altered by changing the environment. There is evidence, for example, that increase in the moisture available to some conifers results in a greater proportion of latewood having thicker walled cells, which means wood of higher specific gravity and higher strength.

Foresters at the University of Illinois have been conducting tree-environment studies for a number of years. Increase or decrease in diameter of experimental trees has been related to tree growth as measured with the microdendrometer. The recent acquisition of a microtome with knife-conditioning equipment will provide the means of adding new information to these studies. Slide sections of woody material from present and past research can be prepared for the study of wood-quality indices at high magnification. It is planned to undertake new studies involving both environment and heredity of trees as related to anatomical characteristics. — *J. K. Guiher*

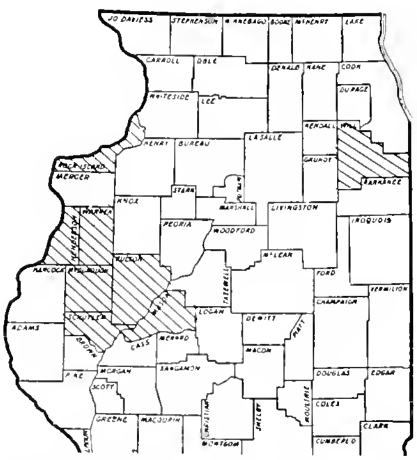


With a sliding microtome, sections of wood only one-fifth the thickness of this page can be cut for microscopic examination.

Virus Control of the European Pine Sawfly

The European pine sawfly, *Neodiprion sertifer* (Geoff.), was accidentally brought into this country sometime before 1926. By the early 1950's it was causing heavy defoliation to pines in the Henderson County State Forest. Since then it has spread to seven other counties in northern Illinois (see map below).

Fortunately this insect can be controlled by introducing a polyhedral virus disease into field populations. The virus infects a large percentage of the larvae, killing many of them. Insects that survive the viral infection carry the disease to subsequent generations, so that mortality continues high.



Range of the European pine sawfly in Illinois.

Pines should be checked for larvae from mid-April to early June.

A major problem in recent years has been a lack of available virus concentrate with the proper polyhedral body count and perhaps virulence. As a result the state now has several infestations of this sawfly in which there is no evidence of the virus disease.

Obtaining a reliable virus concentrate, however, should no longer be a problem in Illinois. The Harrisburg office of the U.S. Forest Service, starting this spring, will maintain a supply of the concentrate and will make it available to State Division of Forestry personnel and others for distribution to Illinois landowners. It is hoped that all known infestations in the state can be treated in 1964.

For best results, the virus should be introduced into sawfly populations as early as possible in the spring. If you own susceptible trees such as Scotch, red, and jack pines, you are urged to check your plantations from the middle of April until early June. If you find this sawfly, ask the farm forester in your area for advice immediately. — *R. G. Rennels*

Chemically Defined Diets Developed for Studies of Chick Nutrition

The use of purified diets has contributed much to present-day concepts concerning nutrient requirements and nutrient interrelationships for a wide variety of domesticated animals. Such a diet would contain a source of carbohydrate (glucose, sucrose, starch, etc.), a purified intact protein (casein, wheat gluten, isolated soybean protein, etc.), some fat (corn oil, lard, etc.), plus vitamins and a salt mixture.

When a mixture of crystalline amino acids is substituted for the intact protein, the purified diet more nearly approaches a chemically defined diet. For more than a decade the Poultry Division has been working to develop a chemically defined diet for use in chick-nutrition studies. Growth was only one-fifth of normal on the first crystalline amino acid mixtures used. With time, however, the pattern (balance) of amino acids in the crystalline amino acid mixture was gradually improved and finally in 1961 a mixture was devised that would support chick growth as well as a ration formulated from natural feedstuffs (corn, soybean meal, etc.). This chemically defined diet is being used as a reference standard to examine amino acid interrelationships. — *H. M. Scott*

Niacin in Certain Cereals Is Unavailable to the Pig

Five experiments, involving 163 pigs with an approximate average initial weight of 30 pounds, were conducted to determine the nicotinic acid (niacin) requirement of the weanling pig. The diets used were varied in the levels of yellow corn and the level and source of supplementary protein.

Following are four of the diets and the amount of *total* nicotinic acid needed per pound of diet to support a satisfactory rate and efficiency of gain:

	Diet (1)	*Diet* (2)
Yellow corn, pct.	0	40
Vitamin-extracted casein, pct.	14	12
Tryptophan, pct.	0.10	0.12
Total nicotinic acid, mg.	5.14	10.90

	Diet (3)	*Diet* (4)
Yellow corn, pct.	80	80
Vitamin-extracted casein, pct.	8	10
Tryptophan, pct.	0.12	0.19
Total nicotinic acid, mg.	14.33	10.32

A fortified corn-soybean oil diet, such as is normally used, contained 16.2 percent protein, 0.23 percent tryptophan, and 10.22 mg. of total nicotinic acid, and was not improved by the addition of nicotinic acid. It is likely that the need for adding nicotinic acid was eliminated by the additional tryptophan.

Assuming that the nicotinic acid of yellow corn is largely unavailable,

the minimum requirement for nicotinic acid is about the same for the various levels of corn. However, the need varied indirectly with the level of dietary tryptophan fed in excess of that needed for growth.

The separate addition of 0.01-percent L- or DL-tryptophan, 6 mg. niacin per pound, or 5 percent wheat bran significantly increased performance on the 80-percent corn diet. The weanling pig needs approximately 6 mg. of available nicotinic acid per pound of diet when the minimum tryptophan requirement is provided in the diet. — *D. E. Becker*

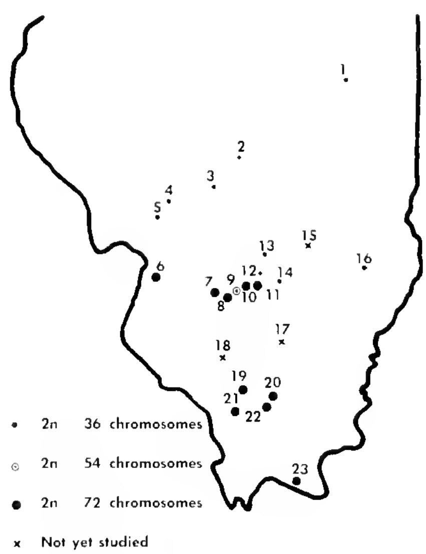
Tripsacum Growing in Illinois Is Found to Have Varying Numbers of Chromosomes

The genus *Tripsacum* is an important relative of corn which, like corn, is native to the New World. Several species of *Tripsacum* grow in a wild state in most of Central America and Mexico as well as in parts of the United States and South America. One important species, *T. dactyloides,* is found along the Eastern Seaboard, on the Great Plains and prairies, and in the southern states. This is a very variable species which could be divided into various classes, each with somewhat different morphological characters.

T. dactyloides has been located in 23 different places in Illinois, mostly in the central and southern counties. Stocks from each site are being vegetatively propagated on the Agronomy South Farm, from cuttings collected by Dr. J. B. Beckett and Mr. R. J. Lambert (ILLINOIS RESEARCH, Fall, 1963).

The different clones vary greatly in height, maturity, and leaf thickness. It was suspected that different clones might have different chromosome numbers, since this species has been found to possess either 36 or 72 somatic chromosomes. To study the chromosome number, male portions of the developing inflorescences were removed at the appropriate stages and fixed in a 3:1 mixture of absolute alcohol-glacial acetic acid. After 48 to 72 hours, they were removed from the fixative and stored in 70-percent ethyl alcohol. Chromosome counts were made in the late diplotene or early diakinesis on the acetocarmine smears of young anthers.

Cytological examination has been made on 20 clones. The 3 remaining clones have not yet flowered. Besides somatic chromosome numbers of 36 and 72, one clone has been found with 54 chromosomes. All the clones with 36 chromosomes are from central Illinois, whereas clones from southern counties have 72 chromosomes (see map). It is possible that the clones with 36 chromosomes are more cold-resistant than the ones with 72 chromosomes; however, our observations indicate otherwise. The clones with different chromosome numbers have shown equal tolerance to cold, since they have all been growing satisfactorily on the Agronomy South Farm for more than two years, including the very cold winter of 1962-63.



Sites of *Tripsacum dactyloides* collection in Illinois, and chromosome numbers of the clones. 1, Urbana; 2, Stonington; 3, Harvel; 4, Carlinville; 5, Shipman; 6, Horseshoe Lake; 7, Beckemeyer; 8, Carlyle; 9, Huey; 10, Shattuc; 11, Sandoval; 12, Patoka; 13, Shobonier; 14, Alma; 15, Watson; 16, Olney; 17, Opdyke; 18, Pinckneyville; 19, Elkville; 20, Freeman Spur; 21, Murphysboro; 22, Herrin; 23, Metropolis.

All the species growing in Central America and Mexico have 72 chromosomes. *T. floridanum* is a slender species with 36 chromosomes confined to a very small area in southern Florida. It probably is on the verge of extinction. Very likely *T. dactyloides* was originally a species with 36 chromosomes. The 72-chromosome forms probably originated in the south by doubling of the chromosome number. These forms being more vigorous, they may have been constantly replacing the types with 36 chromosomes.

The cytological situation within the species *T. dactyloides* is very complex and there is evidence of both autopolyploidy and allopolyploidy within the species. It is not known how doubling of chromosomes took place and whether it involved any other genome. No representives of the genus *Tripsacum* are known with less than 36 somatic chromosomes; the nearest related 18-chromosome form is the genus *Manisuris* of the tribe Andropogonae. Attempts to hybridize *Tripsacum* and *Manisuris* are underway in the Agronomy Department and interesting results are expected. — *S. C. Anand*

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

Jan. 14-16: Farm Mechanization Workshop

Jan. 22-23: Illinois Custom Spray Operators' Training School

Jan. 23-24: Agricultural Industries Forum

Jan. 23-24: State Fertilizer Conference

Jan. 27-29: Rural Pastors' and Lay Leaders' Short Course

Jan. 27-Mar. 6: Winter Short Course in Agriculture and Home Economics

Mar. 14: Ag Student Guest Day and Home Economics Hospitality Day

Mar. 20: Cattle Feeders Day

Mar. 24: Swine Day

FARM BUSINESS TRENDS

MANY CITIZENS are becoming increasingly interested in foreign trade. Some want to find or expand foreign markets for their products. Some wish to obtain useful raw materials or manufactured items from other countries. Others are concerned about the competition provided by imported products.

Individuals and business firms can make profits from exporting as well as from importing. As a nation, however, the gain from foreign trade is not in giving up products of our farms and factories, but in obtaining useful materials from other lands.

Our dependence on imports is increasing. As shown in Figure 1, the total value of imports increased from about $2 billion a year before World War II, to $16 billion in 1962.

Most of our imports — 60 to 65 percent — do not compete with domestic production. They are raw materials and manufactured products that are either not produced in the United States, or cannot be economically produced in sufficient amounts to meet our demands.

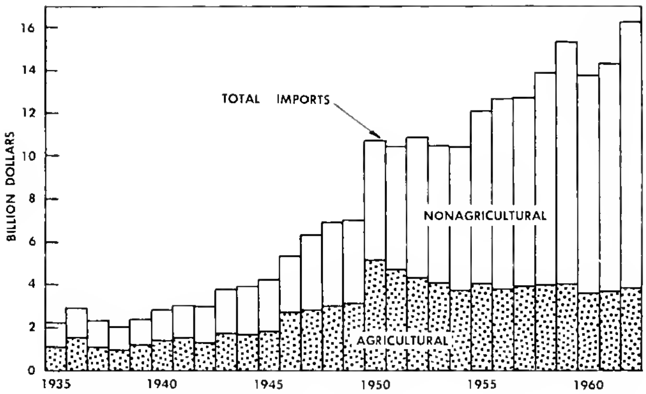
We depend upon imported supplies for most of our aluminum, chrome, manganese, industrial and cut diamonds, tin, nickel, newsprint, wool, and natural rubber. Foreign countries also supply us with all or most of our asbestos, abaca and sisal, burlaps and jute bagging, and fluorspar. We import about one-third of our iron ore and copper, and one-fifth of our petroleum.

Our leading agricultural import is coffee, which is not produced in this country. Other important non-competitive agricultural imports are crude rubber, cocoa and cacao beans, carpet wool, bananas, tea, spices, and silk. The value of non-competitive agricultural imports in 1962 was $1,740 million, or 45 percent of all agricultural imports.

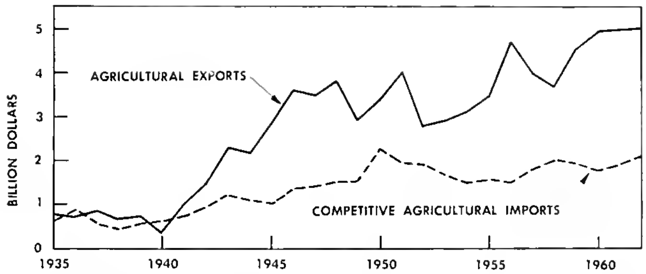
Non-agricultural imports have been increasing much more rapidly than agricultural imports. The value of non-agricultural imports is now about 12 times as great as before World War II, while the value of agricultural imports is only 4 times as great.

The balance of agricultural trade has moved strongly in favor of the United States during the past 30 years. As shown in Figure 2, the value of our agricultural exports and competitive imports were about equal before World War II. Both were around $750 million a year. Since then, our exports have increased to $5 billion, while imports of competitive products have been around $2 billion in recent years.

— *L. H. Simerl, Professor of Agricultural Economics*



Value of U.S. imports, 1935-1962. (Fig. 1)



Value of U.S. agricultural exports and of competitive agricultural imports, 1936-1962. (Fig. 2)

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Spring, 1964

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Rumen contents are quickly analyzed by use of gas chromatography. After a sample is injected onto the column, the analysis appears on the recorder (page 12).

Volume 6, Number 2 COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard . . . . Dean and Director

M. B. Russell . . . . Associate Director

Adrian Janes . . . . Station Editor

Margery E. Suhre . . . . . Editor, ILLINOIS RESEACH

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DEANS OF THE COLLEGE OF AGRICULTURE: ROBERT R. HUDELSON

Robert R. Hudelson, sixth Dean of the College, once described himself as "a person who seems to collect jobs as sheep collect burrs." This description is an apt one. During his 29 years of distinguished service to the University of Illinois, Hudelson held an almost unparalleled number of administrative positions, including the deanship of one college and the acting deanship of another.

Dean Hudelson was born on a farm near Chambersburg, Illinois, in 1886. He received his B.S. and Ph.D. degrees from the University of Illinois, and his M.A. degree from the University of Missouri. After teaching at Missouri for several years (with time out for service as an artillery captain in World War I), Hudelson joined the Doane Agricultural Service as a farm manager in 1922. Three years later, he returned to the University of Illinois as Assistant Professor of Farm Organization and Management Extension.

In 1933, Hudelson worked with Dean H. W. Mumford in administering the Agricultural Adjustment Act in Illinois. During the next 20 years, he served successively as Assistant Dean, Associate Dean, Acting Dean of the College of Commerce, and Acting Dean of the College of Agriculture. In March, 1953, he was appointed to succeed Henry P. Rusk as Dean of the College.

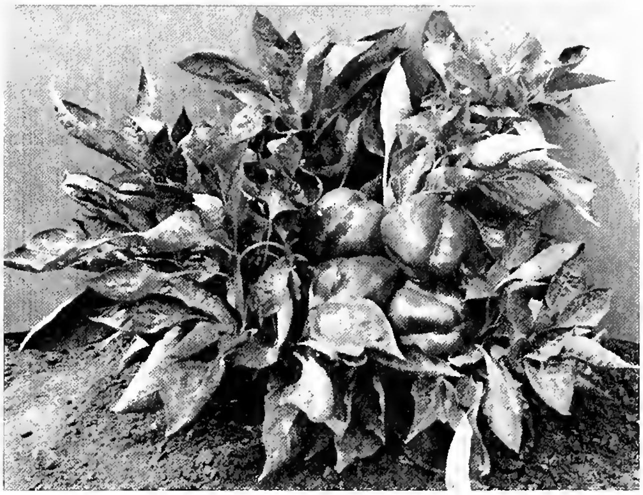
Dean Hudelson was a founding trustee and vice-chairman of the Agricultural Institute, St. Louis, an accredited member of the American Farm Economic Association, a Fellow in the American Association for the Advancement of Science, and a charter member of the American Society of Farm Managers and Rural Appraisers. In 1953, the Society presented Hudelson the D. Howard Doane Award "in recognition of his many years of courageous, unselfish, and effective leadership in the field of agriculture, and in appreciation of his many contributions, his integrity, and his fine Christian character."

Since his retirement from the University in 1954, Dean Hudelson has been manager of the Farm Department of the Champaign County Bank and Trust Company. He was succeeded as Dean of the College of Agriculture by the present Dean, Louis B. Howard. — *R. G. Moores*

LINCOLN BELL,

a new Illinois variety of sweet pepper

A. E. THOMPSON



Lincoln Bell combines many of the qualities considered desirable for both commercial and home gardens. It is vigorous, produces good-quality fruits, yields well over an extended period, and is resistant to tobacco mosaic virus.

ILLINOIS has long needed a variety of garden pepper that will produce large yields of both early and main-season fruits and also have the characteristics of a commercially acceptable variety. These include good shape, color, and quality in the fruits, as well as vigor and disease resistance.

A breeding program aimed at producing such a variety was begun in 1953. At that time Yolo Wonder was crossed with Allbig, a variety which had been developed by B. L. Weaver, formerly of the Horticulture Department, and which had been released in 1945. Allbig produces high yields both early and later in the season but lacks the desirable blocky fruit shape of Yolo Wonder. Besides producing good fruits, Yolo Wonder is also resistant to tobacco mosaic virus.

The first generation (F_1) of the cross was grown in 1954, and the F_2 plants were grown in 1955. Single plant selections were made and evaluated in succeeding years. By 1961, when the selections were in the eighth generation, the best ones were tested in a yield trial and were compared with standard varieties.

The most desirable selection, Illinois 1003-205, has been tested for the last two years under widely varying conditions within the state and in many areas throughout this country and Canada. It performed so well that the decision was made to release it this year under the name of "Lincoln Bell." The data given in the table are for Urbana in 1963, but they are typical of the way Lincoln Bell has compared with commercial varieties in previous years and at other locations.

Performance and Fruit Characteristics of Lincoln Bell Pepper, Compared to Commercial Varieties, Early Harvest and Season's Harvest, Urbana, 1963

Variety	Yield, 25-lb. bu./acre		Av. no. of fruits/plant		Av. fruit weight, lb.		No. of lobes, pct. distribution				Av. no. of lobes
	Early	Season	Early	Season	Early	Season	2	3	4	5	
Lincoln Bell	266	753	2.9	8.3	.40	.39	1	44	52	3	3.6
Illinois #6	245	644	2.6	7.1	.41	.39	3	40	53	4	3.6
Allbig	246	627	2.9	8.2	.36	.33	1	44	49	6	3.6
Delaware Belle	203	573	2.4	7.1	.36	.33	2	53	42	3	3.5
Yolo Wonder	189	473	2.0	5.4	.40	.38	2	52	43	3	3.5
Keystone Resistant Giant	155	420	1.5	4.6	.44	.40	1	39	56	4	3.6
Pennwonder	96	402	1.4	6.0	.30	.29	7	63	29	1	3.2
Calwonder	69	263	0.8	3.8	.36	.29	4	64	31	1	3.3

Lincoln Bell plants have a vigorous, erect growth habit, and are normally about 20 inches tall. The initial set of fruits is usually in the center of the plant, well above the soil. Although the leaves tend to roll, they are relatively broad and provide enough cover to protect the fruits from sunscald under most conditions. The variety appears to have about as much field resistance to tobacco mosaic virus as does Yolo Wonder.

The fruits are dark green, thick in flesh, and of good quality. They are relatively large and blocky, averaging 3½ to 4 inches in both length and width, and 6 to 7 ounces in weight. Fruits are usually 3- or 4-lobed, with the percentage of 4-lobed fruits being generally higher than that of most commercial varieties. Some fruits, especially those with 3 lobes, may taper slightly toward the blossom end. The fruits are smooth, without deep indentations at the blossom end.

The outstanding feature of this variety is its ability to produce heavy sets of good-quality fruit in the cool of the season and to continue producing throughout the season. This feature makes Lincoln Bell desirable for home gardens as well as commercial market gardens.

Seed of Lincoln Bell is commercially available on a limited basis for the 1964 crop season. Bona fide seed producers may also obtain foundation seed for increase for commercial sale. Inquiries about foundation seed should be directed to the author in care of the Horticulture Department, University of Illinois.

A. E. Thompson is Professor of Vegetable Crops, Horticulture Department.

SORGHUMS FOR SUMMER PASTURES

A. W. BURGER, J. A. JACKOBS, and C. N. HITTLE

DURING hot, dry summer weather, when many pasture species go dormant, Sudangrass and allied sorghum species continue to yield well, thus filling the need for supplemental midsummer pasture.

Livestock farmers no longer need to fear these species when properly managed, although to many farmers the words sorghum and Sudangrass are still synonymous with poison and death of livestock.

True, the sorghums are among the many species which have prussic acid potential, and prussic acid is a deadly poison to both plants and animals. We use the term, "prussic acid potential," because the prussic acid is derived from the breakdown of a glucoside known as dhurrin. The chemical reaction is $C_{14}H_{17}O_7N \rightarrow HCN$ (prussic acid) + parahydroxybenzaldehyde + dextrose. When this reaction takes place in the digestive tract of an animal, it can cause death.

This disastrous effect can be avoided, however, thanks to research since the turn of the century. Many studies have been conducted on prussic acid potential and the ways in which it is affected by environment, inheritance, stage of maturity, and management. As a result, we know that by selecting the proper varieties and by proper grazing management we can take advantage of the tremendous pasture potential of these species without loss of animals.

New hybrids studied

In recent years hybridization has increased the yield potential of Sudangrass and sorghums. Piper Sudangrass, for example, is very productive under Illinois grazing conditions, is resistant to many diseases, and is also very low in prussic acid potential. It resulted from a series of crosses among lines low in prussic acid, Tift, and a Texas selection, followed by repeated testing and selection.

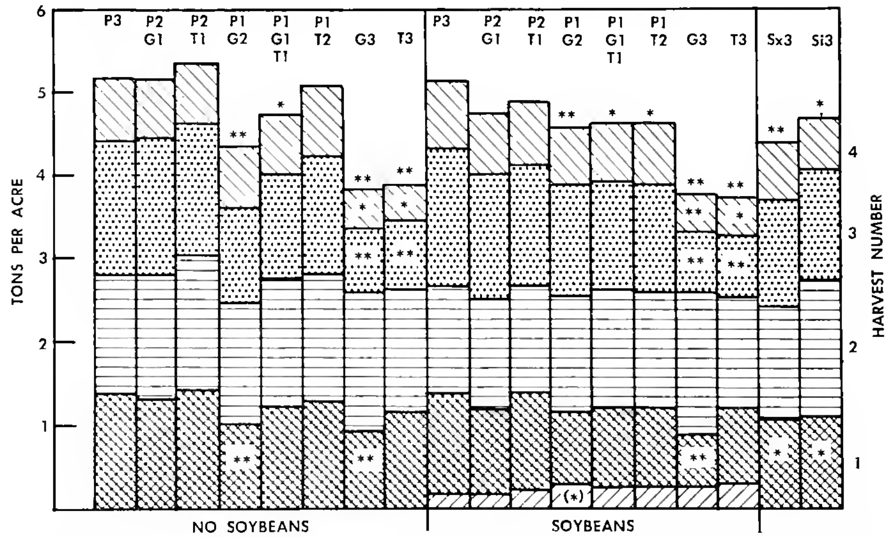
SX-11, an F_1 hybrid, was produced by crossing male-sterile Kafir with a cross of Sweet and Greenleaf Sudangrass. Another F_1 hybrid, Suhi-1, was developed from a cross of male-sterile Rhodesian Sudangrass and Tift Sudangrass. Both of these hybrids have demonstrated the hybrid vigor that is so well known in hybrid corn. They have given high forage yields, especially when cut two or three times a season. Unlike Piper Sudangrass, however, SX-11 and Suhi-1 are relatively high in prussic acid potential.

In 1962 and 1963 we conducted a study of these three hybrids in an attempt to answer several questions:

Can herbage production be maintained when top growth is removed under simulated pasture conditions (four times during the growing season and at a cutting height of 2½ to 3 inches)?

Can herbage production be increased by adding pearl millet or soybeans (or both) to the Sudangrass varieties or hybrids?

Will pearl millet or soybeans reduce the prussic acid potential of the sorghum species?



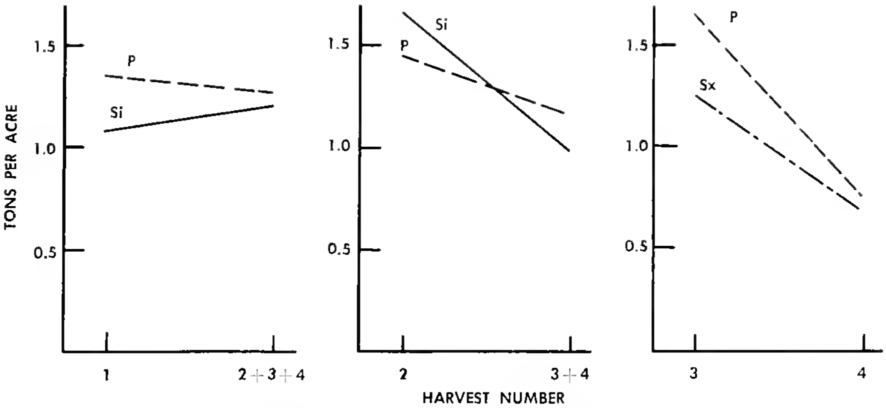
Herbage yields of Piper Sudangrass and pearl millet mixtures grown with and without soybeans, 1962-1963 average, Urbana. Letters have these meanings: P, Piper; G, Gahi-1 (F_1 hybrid pearl millet); T, Texas 7 (early pearl millet variety); Sx, SX-11; Si, Suhi-1. Figures after the letters indicate seeding rate in number of 8-pound units. P3, for example, means 24 pounds of Piper. *Significantly different from Piper (P3) without soybeans. **Highly significantly different. (*) Soybean component of first harvest differs significantly from soybean component of Piper (P3)-soybeans mixture. Asterisks inside bars refer to individual harvests; those above bars, to total yields. (Fig. 1)

Herbage yields

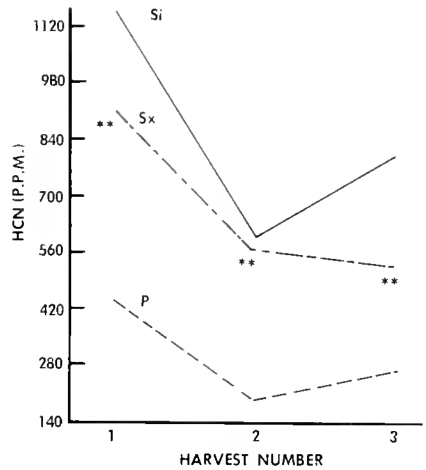
Herbage yields of Piper Sudangrass and pearl millet mixtures when grown with and without soybeans are shown in Figure 1. Piper Sudangrass seeded at 24 pounds per acre was superior to pure stands of pearl millet and, in general, to the mixtures that contained 16 pounds or more of pearl millet. Pure stands of Piper were also superior to pure stands of either SX-11 or Suhi-1 under the management system used in this study. In other studies where cutting height was 5 or 6 inches and herbage was removed three times or less, SX-11 has been superior to Piper.

Herbage yields were not increased

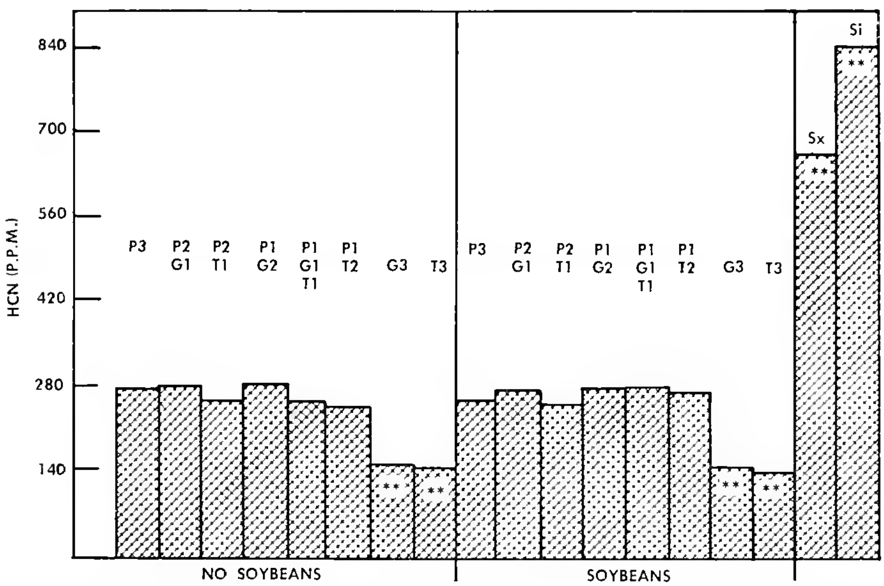
A. W. Burger is Professor of Agronomy; J. A. Jackobs, Professor of Crop Production; and C. N. Hittle, Associate Professor of Plant Breeding.



The yield difference between Suhi-1 and Piper was much greater for the first harvest (1962-1963 average) than for the average of harvests 2, 3, and 4. Suhi-1 outyielded Piper at harvest 2, but not at harvests 3 and 4. The difference between Piper and SX-11 was much greater at the third than at the fourth harvest. (Fig. 2)



Prussic acid (HCN) content of Suhi-1, SX-11, and Piper herbage (1962-1963 average, Urbana). **Highly significantly different from Piper. (Fig. 4)



Prussic acid (HCN) in herbage of Piper Sudangrass and pearl millet mixtures, grown with and without soybeans, 1962-1963 average, Urbana. See Figure 1 for explanation of letters and figures. **Highly significantly different from Piper (P3). (Fig. 3)

by seeding 2 bushels of Harosoy soybeans with the Piper Sudangrass-pearl millet mixtures (Fig. 1). In fact, the soybeans appeared to reduce total seasonal yields. The soybean herbage component of first harvest yields was very disappointing. Results were similar when soybeans were seeded with SX-11 and Suhi-1. Apparently there isn't enough growing time for soybeans to become well established. Moreover, competition from the sorghums is tremendous.

Some comparisons between the yields of Piper, Suhi-1, and SX-11 at different harvests are given in Figure 2.

Prussic acid content

As shown in Figure 3, the average prussic acid content of Piper Sudangrass was greater than that of the pearl millets in pure stands, but less than that of SX-11 and Suhi-1.

The addition of soybeans or pearl millets to Piper Sudangrass had little effect on prussic acid content of the Sudangrass. The same thing was true when soybeans and pearl millets were grown with Suhi-1 and SX-11.

The prussic acid content in the herbage of Suhi-1, SX-11, and Piper for the first three harvests (average of 1962 and 1963) is shown in Figure 4. At each harvest both Suhi-1 and SX-11 contained significantly more prussic acid than Piper. All three varieties contained more prussic acid at the first harvest than at the second and third harvests.

Piper a good choice

It is usually safe to pasture when the herbage contains less than 500 parts per million of prussic acid, doubtful at 500-750 p.p.m., and dangerous above 750 p.p.m. It can readily be seen that the prussic acid content of Piper is well below the dangerous level for grazing. This fact, plus high yields, makes Piper an excellent choice for midsummer grazing.

The other two hybrids, especially Suhi-1, are high in prussic acid potential. Soybeans or pearl millet, however, will dilute the prussic acid in the herbage accessible to the animal. Further, since the sampling is made on 8- to 10-inch tillers, which have more dhurrin than other plant parts, the sampling technique overestimates the total amount of dhurrin in the forage. It seems reasonable to assume that, with good management, SX-11 and possibly Suhi-1 can be grazed safely.

Breeding Improved Varieties of Eastern COTTONWOOD

J. J. JOKELA

ONLY REMNANTS are left of the vast virgin forests which were once our national heritage. Soon most, if not all, of our wood requirements will be met only through conscientious effort, as are our food requirements.

Even though our forest areas continue to dwindle, the remaining acres are becoming more productive as the transition is made from natural to man-made forests. With this transition, however, have come the added costs of sowing and of long years of tending. Loss of the competitive advantages of wood is now a greater threat to our continued use of wood as an industrial raw material than is the diminished specter of timber famine. The challenge of forestry is to produce higher yields of wood of specified and uniform quality on shorter rotations at costs which are not prohibitive. Good management practices must be augmented with improved, better yielding varieties.

Since World War II, forest tree improvement programs have been initiated the world over. The rapid development of these programs heralds the eventual domestication of forest tree species.

The genus *Populus*, represented by some 30 species throughout the north temperate zone, offers more attractive possibilities for genetic improvement than perhaps any other tree species. Most of the tree improvement studies at the Illinois Experiment Station have been with our native eastern cottonwood (*Populus deltoides* Bartr.). It is the fastest growing tree species in its native range, which includes most of the eastern half of the United States. Although typically a bottomland species, it will outgrow its competitors on most sites where it can be established.

The species has great genetic diversity and can be crossed with several species of poplars. The ease of handling the species experimentally, the appealing prospect of directly utilizing selected forms and hybrids through vegetative propagation, and a favorable economic outlook make eastern cottonwood a prime candidate for genetic improvement.

Sex ratio and associated traits

Eastern cottonwood is a dioecious species — that is, male and female flowers are borne on separate trees. Since only the seed-bearing female trees shed "cotton," males are preferable as shade trees.

Numerous scientists have suggested that males may predominate in species of *Populus* and that there may be a positive correlation between maleness and important economic traits such as vigor, disease resistance, and good stem form. These suggestions prompted an early survey of the occurrence of sex and secondary sex traits in natural stands in Illinois. A total of 1,165 trees in nine stands were observed for sex and were measured for diameter. Total height and height to the main fork (a measure of stem form and merchantability) were measured in four of the stands. Differences between sexes were not statistically significant (Table 1), indicating no reason to favor male trees in forestry practices.

Premature leaf drop caused by a heavy attack of *Melampsora* leaf rust. At least 2 percent of the cottonwood in wild stands appears highly resistant to this disease, offering the possibility of breeding new resistant varieties. (Fig. 1)

Table 1. — Number, Mean Diameter, Height, and Height to Main Fork of Female and Male Trees by Stand

Stand location (county)	Number of trees[a]		Mean diameter, in.		Total height, ft.		Height to fork, ft.	
	Female	Male	Female	Male	Female	Male	Female	Male
Champaign	48	53	13.4	12.6	. .	. .	. .	. .
Fulton	50	50	10.2	10.4	55	54	28	28
Logan	44	46	13.3	12.7	. .	. .	. .	. .
Mason	54	49	. . . .	. . . .	. .	. .	. .	. .
Piatt	66	57	17.5	17.8	. .	. .	. .	. .
Piatt	115	108	13.2	13.6	77	81	46	51
Piatt	57	64	7.6	7.2	. .	. .	. .	. .
Piatt	38	39	9.1	10.0	57	57	. .	. .
Vermilion	49	69	8.5	9.3	45	47	36	35
Total	521	535	12.0	11.8	57	58	36	37

[a] Of the 1,165 trees observed, 109 or 9 percent had no discernible buds or flowers and therefore could not be sexed. Most of these were small trees in the suppressed and intermediate crown classes which normally bear few or no flowers.

J. J. Jokela received his Ph.D. from the University of Illinois in 1963 and is now Assistant Professor of Forestry, in charge of tree improvement studies.

Eastern cottonwood at 4 years of age in the Sangamon Forest Plantation near Monticello, Illinois. The full-foliaged trees on the left belong to the southern Illinois population. They retain their leaves 2 weeks longer than trees of the local or east-central population pictured at right. The southern Illinois population was also 39 percent taller, on the average, at the end of the fourth growing season. (Fig. 2)

Table 2. — Mean Height of Seedlings on Upland and Bottomland Sites at 3 and 4 Years of Age

Origin of population	Upland 3 yr.	Upland 4 yr.	Bottomland 3 yr.	Bottomland 4 yr.
		feet		
Southern Ill.	5.0	8.2	7.4	10.8
West-central Ill. . .	4.4	6.7	6.5	8.9
East-central Ill. . . .	4.0	5.9	5.8	7.8

Plantations established

Foresters have long been aware of heritable differences within tree species. Differences due to geographic variation have been amply demonstrated. Far less is known of the nature, extent, and heritability of genetic variation among individual trees. Such variation cannot be studied in wild stands because of the confounding effect of differences in age, environment, and genetic background. Controlled experiments with trees of known origin and genetic relationship are necessary for the intelligent development of tree improvement programs.

A study of heritable variation in eastern cottonwood in Illinois, employing methods used by animal breeders, was begun in 1959. Material for the study consisted of seed from 104 unrelated trees and cuttings from 108 unrelated trees representative of a southern Illinois population and two central Illinois populations.

Seedling plantations were established in an upland site near Urbana and a bottomland site near Monticello. Data from these plantations are being used for narrow-sense estimates of heritability. (Heritability is the heritable fraction of phenotypic or observed variance in a given trait in a given population.) Narrow-sense estimates indicate how much of the average difference between two parents we can expect to find in their progeny. Such estimates are useful in predicting breeding values.

The cuttings from the 108 trees were planted near the bottomland seedling plantation. Data are being used for broad-sense estimates of heritability. These estimates consider total genetic variance as heritable variation and are useful for predicting gains from selection when vegetative propagation is employed. They are particularly applicable to cottonwood, which is readily propagated from stem cuttings.

Variations found

During the first four years of growth, substantial variations were found in nine different traits related to rate of growth, branching habit, disease resistance, leaf shape, and onset of winter dormancy. Although these data do not necessarily indicate mature performance, heritability estimates based on them indicate possibilities for genetic improvement of the particular traits measured.

Significant differences were found between populations for all traits studied except leaf shape. These differences are expressed more strongly in the seedling plantations than in the clonal or cutting plantation and are greatest between the southern Illinois population and the two central Illinois populations. The most striking difference is in rate of growth. When three years old, seedlings from the southern Illinois population had a mean height 25 percent greater than that of the east-central Illinois population in the upland plantation, and 28 percent greater in the bottomland plantation. The following year the difference had increased to about 39 percent in both plantations (Table 2).

Prospects

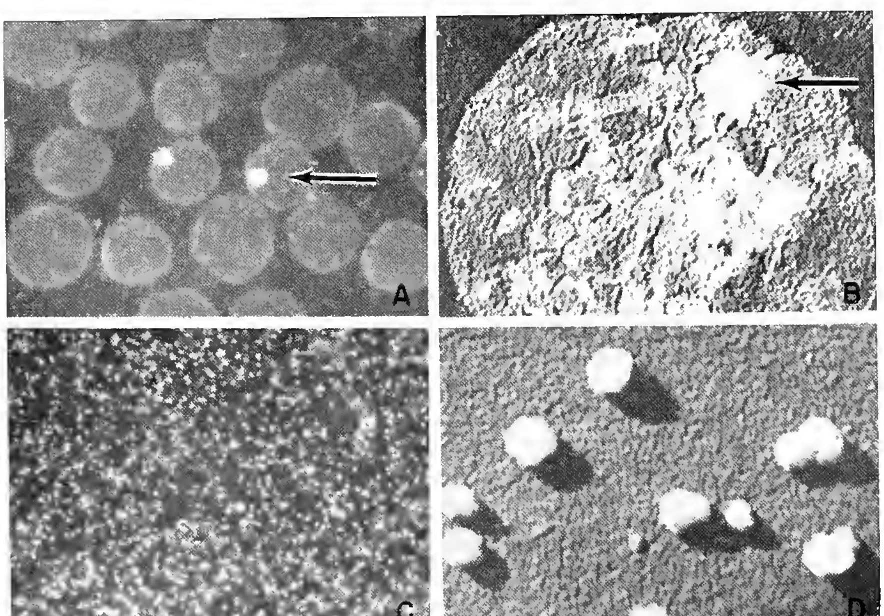
Possibilities for genetic improvement of cottonwood warrant optimism. The vast range of the natural species is an untapped reservoir of genetic variation. Heritabilities of certain traits appear high enough to justify the immediate use of selected trees for seed or cuttings before progeny or clonal testing. Prospects for further improvement through selective breeding between and within ecotypes (subspecies) are good. Interspecific hybrids offer still another avenue for genetic improvement.

Until techniques for inducing early flowering and for ascertaining mature performance at young ages are developed further, the tree breeder must labor under a severe time handicap, even with rapidly maturing cottonwood. On the other hand, the breeder of cottonwood need not engage in tedious and endless inbreeding to maintain his breeding stock. Nor is he faced with the death of an "Illini Nellie," a champion of her breed, a few short years after proving her worth. Trees of outstanding breeding value can be maintained as long as need be and outstanding selections may be propagated vegetatively through countless generations.

ANAPLASMOSIS Can Now Be Controlled

MIODRAG RISTIC

Calves with acute anaplasmosis. (Fig. 1)



A. *Anaplasma marginale* stained by the fluorescein-labeled antibody (arrow). B. Electron photomicrograph of an erythrocyte infected with *Anaplasma marginale*. The *Anaplasma* body consists of five subunits known as initial bodies (arrow). The initial body is considered to be the actual agent responsible for the infection. C. Initial *Anaplasma* bodies stained by the fluorescent antibody. These initial bodies serve as the antigen in the capillary tube-agglutination (CA) test. D. The initial *Anaplasma* bodies viewed by electron microscopy. (Fig. 2)

THROUGH RESEARCH in the College of Veterinary Medicine, it is now possible to control anaplasmosis, a disease that has been recognized for nearly half a century as a severe economic threat to the cattle industry in many areas of the world. In the United States alone, the estimated cost of the disease is 35 million dollars a year. Anaplasmosis has been reported in 40 states. It is endemic in southern Illinois, and individual outbreaks have occurred in other parts of the state.

The disease is manifested by progressive anemia associated with the presence of parasitic bodies known as *Anaplasma marginale* in the erythrocytes (red blood cells). The exact means by which anaplasmosis is perpetuated in nature is little understood. Agents that can transmit minute quantities of blood from infected to susceptible animals are considered responsible for spreading the

Miodrag Ristic is Professor of Veterinary Pathalcgy and Hygiene, and Senior Staff Member, Center for Zoonoses Research. The machine in the picture is a spectrophotometer, which standardizes the concentration of antigen used in the CA test.

disease. Among natural vectors are ticks, horseflies, mosquitoes, and other species of arthropods. Some of these agents are biologic vectors, while others are mechanical carriers.

Symptoms

In the early stages of acute anaplasmosis, the most commonly observed symptoms are rise of temperature, exhaustion, and loss of appetite. As the disease progresses, skin, udder, teats, brisket, mouth, vagina, and sclera of the eyes generally become yellow and pale. Urination is frequent but the urine is not bloody. The animals are usually constipated and the feces are dark, blood-tinged, and partly covered with mucus. Abortion is somewhat common in advanced cases of pregnancy. Death may follow two or three days after the symptoms first appear. Two calves with acute anaplasmosis are pictured in Figure 1.

Carrier stage

Unfortunately, all cattle that recover from acute anaplasmosis become carriers of the disease even though they appear normal. They themselves develop an immunity, as manifested by a persistence of the parasite and long-continued quiescent infection. When introduced into clean herds, such animals become sources of infection, particularly if ticks, horseflies, or other vectors are present.

Before anaplasmosis could be controlled, it was essential to develop a test that would determine the presence of unknown carrier cattle.

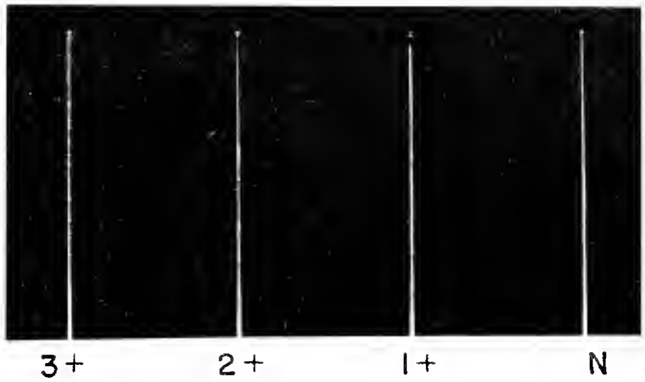
Development of CA test

With Romanowsky's method of staining or the fluorescent antibody technique, *Anaplasma* appears in the red blood cells as dense, homogeneous, bluish-purple or brilliant yellow, round bodies 0.3 to 1.0 micron in diameter (Fig. 2A). Examination of the marginal *Anaplasma* body by electron microscopy revealed that it consisted of several subunits which we designated initial bodies (Fig. 2B, arrow). In further studies, the initial *Anaplasma* body was found to be the actual agent of anaplasmosis, capable of attaching to and entering the red blood cells of the cow. Once the initial body enters a blood cell, it begins to multiply by binary fission, which results in the formation of the marginal body. This stage of the development of the organism is observed during the acute stage of the disease.

With this preliminary information on hand, we attempted to devise a method of liberating initial bodies from the red blood cells of acutely infected cattle. We felt that the cell-free initial bodies could then be used as an antigen for detection of serum antibody in *Anaplasma*-infected cattle. The free initial *Anaplasma* bodies, liberated from infected erythrocytes by a special method, are pictured in Figure 2C, D).

The capillary tube-agglutination (CA) test proved a simple and most economical method of attaining a reaction between the initial *Anaplasma* bodies (antigen) and the serum from a suspect animal. Carrier animals, which harbor *Anaplasma* yet do not show any clinical symptoms, have antibodies against *Anaplasma* in their blood serum and these antibodies react in the CA test with our antigen (suspension of the initial *Anaplasma* bodies).

Depending upon the concentrations of serum antibodies, we may observe three different degrees of agglutination (Fig. 3). If a serum sample causes any degree of agglutination, the donor animal is an active carrier of anaplasmosis.



Anaplasmosis capillary tube-agglutination (CA) reactions are: 3+, strongest positive; 2+, strong positive; 1+, positive; N, negative. (Fig. 3)

Field application of test

We have used the CA test in southern Illinois to control anaplasmosis in a herd of about 1,000 cattle, which had a history of repeated outbreaks and losses due to anaplasmosis during the previous 10 years. In the winter of 1961-62 we tested all animals in the herd and identified 72 reactors. These reactors were grouped as a separate herd, about a mile away from the negative animals.

The test and segregation program proved to be a great success. During the summer of 1962 not a single case of anaplasmosis occurred in either herd despite a large horsefly population in the area. On the other hand, herds which were not segregated and were in the same general area as the tested herd experienced outbreaks of the disease. These results demonstrate that the CA test can be used in a practical manner for controlling anaplasmosis in the field.

There are 24 governmental or educational laboratories participating in the application of the CA test. The test is also used by practicing veterinarians. It can be performed in the field without special laboratory equipment or specially trained personnel, and information as to the status of an animal can be obtained without delay. Kits for the performance of the CA test are now sold commercially. A number of foreign countries including Mexico, the Philippines, and Kenya have started using the CA test as a means of controlling anaplasmosis.

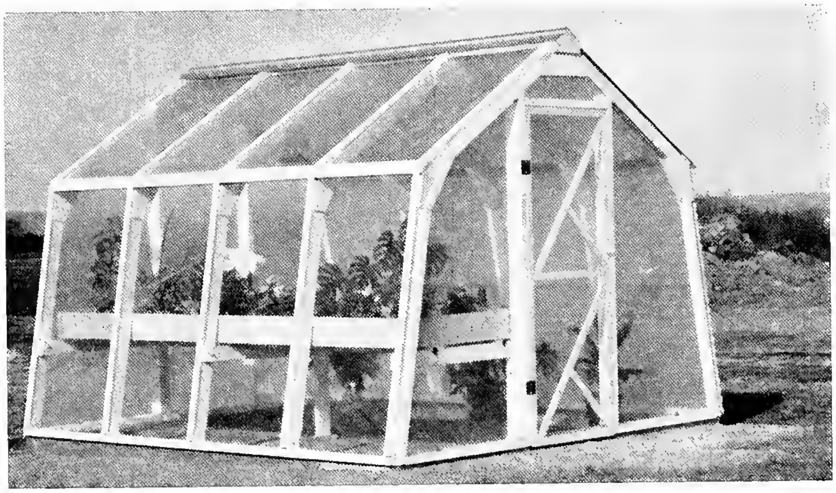
A Small Plastic Greenh

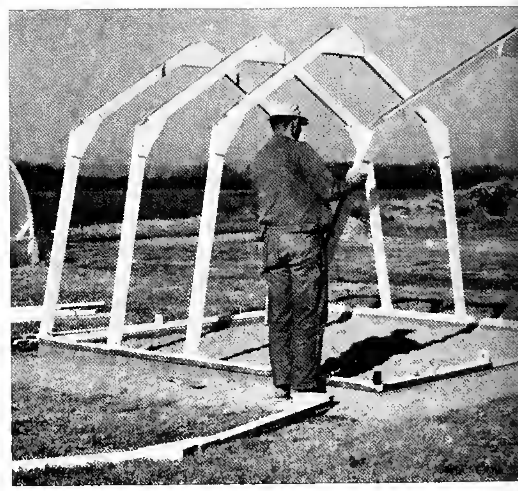
J. W. COURTE

WITH the development of new improved plastics, an inexpensive plastic-covered greenhouse is now practical for the home gardener who enjoys growing vegetables, ornamentals, and flowers all year long. The small rigid-frame greenhouse shown here was designed to take advantage of long-lasting plastic coverings. Features of this do-it-yourself greenhouse are attractive appearance, simple construction, and low cost. The frames can be built with common tools and can be prefabricated inside during bad weather.

Plastic greenhouses have been used at the Dixon Springs Experiment Station since 1960. Different plastics have been tested and have been found to vary widely in durability. The plastics tested, in order of increasing durability, are polyethylene, improved ultra-violet resistant polyethylene, weatherable vinyl, weatherable Mylar (registered trademark for DuPont polyester film), and rigid fiberglass.

Materials for this greenhouse will cost $100 or less if inexpensive polyethylene is used. For growing spring transplants or for temporary use, 4 or 6 mil polyethylene is satisfactory. It is not recommended for year-





This greenhouse is 10 feet wide and 10 feet 8 inches long. A longer greenhouse can be built by adding more rigid frames.

A solid concrete foundation, extending below frost line, is recommended for permanent trouble-free construction.

se for Home Gardeners

). CURTIS

round use as it deteriorates rapidly in summer sunlight and must be replaced each year.

Material costs would run between $150 and $175 when weatherable vinyl is used; $175 to $200 for Mylar; and $300 for corrugated fiberglass. Serviceable life of these plastics should be 2 to 4 years for 8 to 12 mil vinyl, 3 to 5 years for 5 mil Mylar, and 15 years or longer for fiberglass. A permanent aluminum-glass greenhouse of comparable size would cost $600 to $800.

Benches and heating and ventilating equipment would add between $250 and $300 to the above costs. These figures do not include costs for utilities or labor.

A plan and instructions for building this greenhouse are in Illinois Extension Circular 880, *A Simple Rigid Frame Greenhouse for Home Gardeners.* Extension Circular 879, *Home Greenhouses,* gives information on heating and ventilation. To obtain these circulars, write the Agricultural Information Office, 112 Mumford Hall, University of Illinois.

J. W. Courter is Assistant Professor of Horticulture, Dixon Springs Experiment Station; J. O. Curtis is Associate Professor of Agricultural Engineering.

bricated frames
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sill plate with
iron braces. The
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inches apart.

Fiberglass makes an attractive permanent hail-proof greenhouse.

The frame does not have to be notched when corrugated fiberglass is used. The fiberglass is attached with special corrugated strips, spacers, and wood screws. Orchids and foliage plants grow particularly well under fiberglass.

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The greenhouse is designed for two benches 30 to 36 inches wide. A 36-inch prefabricated asbestos cement bench is shown at left. Such benches are available from greenhouse supply companies, as are similar prefabricated redwood benches. Benches can also be made at home. Fine stone chips on the floor under the benches permit water runoff and add to the neatness of the greenhouse.

GAS CHROMATOGRAPHY: A New Tool for Research in Ruminant Nutrition

C. L. DAVIS and R. E. BROWN

Somebody has written, "Rare is the chemist who hasn't longed for the black box that takes a complex sample and magically produces a complete chemical analysis."[1] The development of gas chromatography has come close to making this dream a reality. It's been just a little over 10 years since publication of the first scientific article describing a method used to separate organic compounds in the gaseous state. Today it would be a full-time job just to abstract the publications dealing with gas chromatography. The extensive use of this method for chemical analysis can be attributed to the versatility of the method, simplicity of sample preparation, speed of analysis, sensitivity, and automatic recording of the data. Little more could be desired in a technique.

How gas chromatography works

It is not the purpose of this article to discuss in detail the theory involved in the separation of compounds by gas chromatography or the types of instruments and detecting systems available. However, it might be helpful to those not familiar with the method to illustrate the essential features of the system.

Basically, this is how gas chromatography works: a liquid sample is injected into port A (Fig. 1), where it is instantly volatilized and the vapors are swept onto the column by a carrier gas. The column is packed with an inert solid support which is coated with a thin film of a liquid having a boiling point somewhat higher than the temperature of the oven. As the carrier gas moves the vapors through the column, the various components separate because of differences in vapor pressures and solubilities in the liquid film. The least soluble components will move through the column the fastest; the most soluble compounds, the slowest. As a consequence the various chemical compounds which were in the sample reach the detector at different time intervals. The signal from the detector is transmitted to the recorder, where a permanent record of the analysis is made. Injecting known compounds and noting the time required for each to move through the column is a means of identifying the components of an unknown mixture.

Rumen acids analyzed

Now to the uses made of gas chromatography in research on ruminant nutrition. Since the volatile fatty acids (acetic, propionic, and butyric) are the primary energy-yielding nutrients resulting from the microbial digestion of feedstuffs in the rumen, our attention has been almost exclusively devoted to a study of their production and metabolism. The use of gas chromatography in anlyzing rumen contents for the volatile acids has allowed us to do more intensive studies in this area than would have been possible with the time-consuming techniques of the past.

Specifically we have been able to measure the volatile fatty acids in the rumen fluid and the fatty acid makeup of the milk fat after cows have been fed high grain-low roughage diets with and without bicarbonate supplement. In Figure 2 are shown actual chromatograms of the rumen fluid taken from cows receiving (A) normal type ration, (B) ration high in grain and low in roughage, and (C) ration B plus sodium and potassium bicarbonate.

The levels of propionic acid were much higher in the rumen fluid of cows fed ration B than in the fluid of those fed ration A. Addition of bicarbonate to ration B shifted the fatty acid composition of the rumen fluid to a pattern resembling that of the cows on a normal ration.

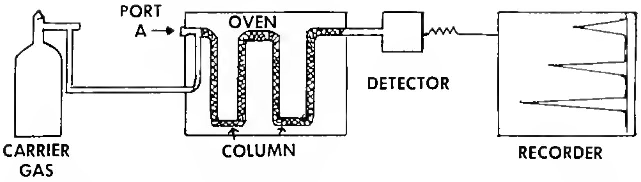
The significance of such shifts in the rumen acids is found by comparing the acids with the fat content of the milk produced (see table). The fat percentage of the milk was significantly reduced when ration B was fed, but the addition of bicarbonate to this ration resulted in the production of milk with a normal fat content. Experiments are now in progress to determine the specific action of the bicarbonate and the amount necessary to maintain the fat content of the milk when high grain diets are fed to lactating cows.

Gas chromatography has been an invaluable tool in these studies primarily because of the rapidity with which the volatile acids in raw rumen fluid can be analyzed. Previous methods would have required 3 to 4 hours for a single analysis.

Composition of butterfat studied

Even more dramatic is the ease with which the fatty acids in butterfat can be completely analyzed with the use of gas chromatography. The fatty acid esters are readily prepared by refluxing them with acidified methanol. The resulting methyl esters of the fatty acids can be completely resolved and the amounts of each determined in a matter of 15 minutes (Fig. 3). Before the advent of gas chromatography most investigators would not have attempted such a complex analysis, and those brave ones who did accomplish the feat had to spend months of tedious and ardent work.

[1] Chemical and Engineering News, June 26, 1961.



Essential components of a gas chromatography unit. (Fig. 1)

Gas chromatography has stimulated the research program concerned with the synthesis of milk fat. In our laboratory, for example, we are studying the effect of feeding unsaturated oils on milk fat composition and the way in which the changes in milk fat composition reflect changes in rumen volatile fatty acids.

Other uses

Another area in which gas chromatography is being put to use is in the analysis of respiratory gases resulting from metabolic studies (Fig. 4). A complex gas mixture can be resolved into its component parts in a matter of minutes. The composition of rumen gas is just as easily determined with this technique.

Finally, gas chromatography has been used to check

Fat Content of Milk Compared With Rumen Acids of Cows Fed Three Rations

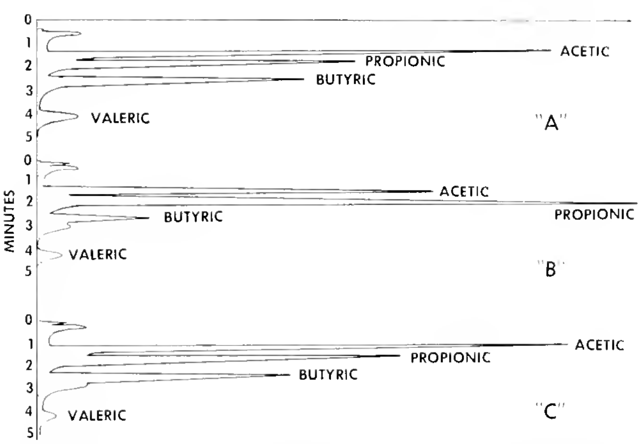
Ration	Fat content of milk, pct.	Rumen volatile fatty acids, molar pct.			
		Acetic	Propionic	Butyric	Valeric
A. Normal	3.20	62.4	23.9	12.3	1.4
B. High grain-low roughage	1.74	47.0	39.8	9.4	3.8
C. Ration B plus bicarbonate	3.22	61.1	25.9	11.3	1.7

the purity of organic chemicals and to identify unknown components resulting from the metabolism of various organic compounds by animal tissues and microorganisms. In addition to the compounds shown in the chromatogram in Figure 5, the methyl esters of the following acids have been chromatogramed successfully: B-OH butyric, glycolic, suberic, azelate, and sebacic.

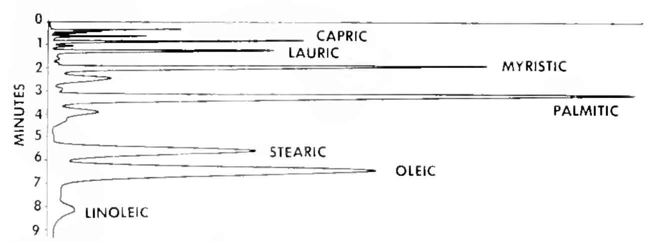
The uses mentioned here for gas chromatography are but few of the many applications of this tool in biological research. As the need arises, more applications of this technique will be made.

C. L. Davis is Assistant Professor of Nutrition and R. E. Brown is Associate Professor of Nutrition, Dairy Science Department.

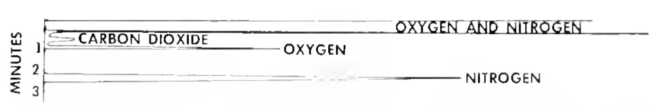
RECORDER RESPONSES



Analysis of rumen fluid samples from cows on three diets: "A" — normal diet; "B" — high grain-low roughage; "C" — Diet B plus bicarbonate. (Fig. 2)



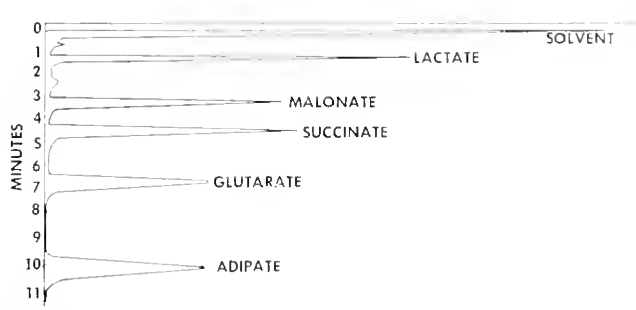
Analysis of methyl esters of milk fatty acids. (Fig. 3)



Analysis of an expired gas sample. In the first peak, oxygen and nitrogen are together, but are separated from carbon dioxide in the second column. (Fig. 4)

CONDITIONS OF ANALYSES, FIGURES 2-5

Fig. 2: Column 5 feet long, inside diameter 1/8 inch; packed with 15-percent diethylene-glycolsuccinate (DEGS) plus 2-percent H_3PO_4 on chromosorb "W" (a silica compound like sand) with a 60/80 mesh particle size. Temperature, 110° C.; carrier gas, 40 ml. per minute; sample size, 0.001 ml. *Fig. 3:* Column size and packing same as above, except 20-percent DEGS and no H_3PO_4. Temperature, 200° C.; carrier gas, 35 ml. per minute; sample size, 0.001 ml. of a 1 to 100 diluted solution of the esters in carbon disulfide. *Fig. 4:* A two-column hookup. First column packed with silica gel; second column with molecular sieve 5A. First column maintained at 80° C., second at room temperature. Carrier gas, 100 ml. per minute; sample size, 0.50 ml. *Fig. 5:* Same as for Fig. 3 except oven temperature was 150° C.



Analysis of methyl esters of mono and dibasic acids. (Fig. 5)

How Good Are Spray Starches?

RUTH LEGG GALBRAITH and LEONA KOCHER

Ever since the advent of wrinkle-resistant cottons, starching has been becoming less of a chore. The resins that give wrinkle resistance to a fabric also give durable crispness. No longer is it necessary for most homemakers to starch a whole load of clothes. For the few clothes in each load that do need starching, the starch manufacturers have developed several products that are easier to prepare and apply than the traditional boiled starch.

First came the precooked starches which are sold in liquid form, and the chemically modified starches which can be applied by suspending them in cold water. Now we have the newest entries on the starch market — those that come in aerosol cans and are sprayed right onto the clothes.

The major advantage of the spray starches is their convenience, since there are no utensils to clean and put away and no need to wait until the wet garment is dry enough to iron. Another advantage of the sprays is that they can be used to starch parts of a garment, such as the collar and cuffs, without starching the whole garment.

Possible disadvantages

Despite the convenience of spray starches, are they as effective as other types?

Dipping a fabric in starch increases its stiffness and smoothness because the starch forms a film which cements the protruding fiber ends to the main body of the yarns This process normally reduces the thickness of the fabric and may increase the ease with which air flows through the fabric (air permeability). As a result, a starched fabric often feels "cooler" to the skin than an unstarched one.

Since a starch spray hits the fabric as droplets, there could be a problem in obtaining a uniform and continuous starch film over the cloth. Furthermore, sprayed starch is applied to only one side of a fabric instead of forming a continuous film around the yarns as when the garment is dipped in starch. It was therefore thought that the spray starches might be less effective than the other starches in increasing fabric stiffness and in binding fiber ends to the yarns.

Two fabrics studied

Two cotton percales without wrinkle-resistant finishes were chosen for this study. One was black, since this color is most apt to show the flaking or powdering of the starch film. The other was light blue, a color that often shows the rings or lines caused by a discontinuation of the starch film or by lack of evenness in its application.

Each fabric was numbered and cut into 24 one-yard lengths. Three of these one-yard samples were selected at random and were tested without any treatment. The remaining 21 samples were washed to remove the sizing applied to them during mill finishing, and then were dried and ironed. Three of these samples were tested without further treatment. Of the remaining 18 samples, three were treated with a boiled starch, using the "light" or lowest concentration recommended on the package; three were treated with a light concentration of precooked liquid starch; and three samples each were treated with four different brands of spray starch. All starched samples were ironed before they were tested.

Before the spray starches were applied to the fabrics, a reproducible technique of spraying was developed by spraying starch onto a glass plate where the size of the starch droplets and the uniformity of spraying could be checked. It was found that the cans had to be shaken vigorously before each use if the starch was to come out in fine droplets of constant size. Even so, after a can had not been used for a day or more, the first starch tended to come out in rather large blobs rather than in droplet form. It was also difficult to confine the spray to a small area.

All fabric samples were tested for thread count, fabric weight, thickness, air permeability, and stiffness. Tests were performed while the fabrics were kept at standard textile testing conditions of 70° ± 2° F. and 65% ± 2% relative humidity, so that changes in the amount of air moisture would not affect the fabric properties.

While the laboratory stiffness test indicates how stiff a fabric will feel to people, the indication is not perfect. Therefore, in addition to the laboratory test, a panel of five persons rated the fabrics subjectively.

Physical Properties of Blue Cotton Percale Before and After Various Starch Treatments

Fabric treatment	Thread count		Weight, oz. per sq. yd.	Pct. starch on fabric	Thickness, in.	Air permeability, cu. ft. per sq. ft. per min.[a]	Stiffness	
	Warp	Filling					Flexural rigidity, mg. cm.	Subjective rating[b]
Original	89	73	3.3	4.4	0.011	67.9	188	3.5
Washed and ironed	89	75	3.3	1.0	0.013	68.7	71	2.1
Boiled starch	89	76	3.3	2.3	0.012	74.0	300	4.5
Precooked starch	88	75	3.3	2.0	0.011	66.3	153	3.7
Spray starch 1	89	76	3.4	1.4	0.013	67.9	95	2.3
Spray starch 2	89	75	3.3	1.3	0.013	69.9	104	2.4
Spray starch 3	88	75	3.3	1.2	0.013	69.9	90	2.4
Spray starch 4	89	75	3.3	1.4	0.013	71.9	115	2.4

[a] Cubic feet of air per square foot of fabric per minute. [b] Ranges from 1 (very limp) to 5 (very stiff).

Leona Kocher, graduate student in Home Economics, measures the air permeability of the black fabric (left). Ruth Galbraith, Associate Professor of Textiles, demonstrates the equipment for measuring cantilever stiffness of a fabric (right). The work reported on these pages was a Master's thesis study that Miss Kocher did under Dr. Galbraith's direction.

SPRAYING TIPS

If the spray starches seem to be the answer to your starching problems, here are some tips for using them satisfactorily:

- **Shake the can vigorously before every use.**
- **Protect the ironing board cover and any nearby furniture from the starch. It is difficult to confine the spray to a small area.**
- **If the can has been standing without use for more than a day, spray the first burst of starch into the sink.**
- **Clean the soleplate of your iron often so that the starch will not scorch on the iron.**

The following rating scale was used: 5 — very stiff; 4 — moderately stiff; 3 — crisp; 2 — moderately limp; 1 — very limp.

The amount of starch in the fabrics after the various treatments was determined by treating them with a starch-solubilizing enzyme to remove the starch.

Boiled and precooked starches compared with no starch

Washing the fabrics caused a slight shrinkage in the warp direction and therefore slight increases in the filling threat counts (testing data for the blue fabric are given in the table). Fabrics were also thicker and less stiff after washing, because the original sizing was removed.

Although boiled starch left more of a starch deposit on the fabric than did any other laboratory treatment, the amount was still less than on the original fabric. However, the samples treated with boiled starch were stiffer than the original fabric as well as being stiffer than the samples starched in other ways. Air permeability was slightly greater in the fabrics treated with boiled starch than in the original samples.

Fabric thickness, 0.013 inch for the washed and ironed sample, was reduced to 0.012 inch by boiled starch but was not returned to the original figure. Precooked starch, however, did reduce fabric thickness to what it was before washing. In general, samples treated with the precooked starch were more like the original fabrics in their properties than were samples treated in any other way.

Spray starch results

The four spray starches were very similar both in results and in ease of application. All of them tended to build up deposits of starch on the soleplate of the iron. This did not happen after the boiled or precooked starch was used.

Spraying caused starch flaking on the black fabric but did not cause rings on the blue. Samples of the blue cloth were given a starch-iodide test to determine whether the spray starch covered the fabric as well as the other starches. It seemed possible that the starch droplets could spread over the entire fabric during ironing. However, the starch films were found to be much less continuous on the sprayed samples than on those starched by immersion.

Only 0.2 to 0.4 percent more starch was deposited on the sprayed fabrics than was present on the samples that had been washed and ironed without starching. The protruding fiber ends were thus not sealed down well on the sprayed fabrics, and these samples were just as thick as the washed and ironed samples. Stiffness ratings were also significantly lower for sprayed fabrics than for the original materials.

Tomato Varieties for Commercial and Home Gardens

J. W. COURTER and J. S. VANDEMARK

THE TOMATO not only is an important early fresh market crop in Illinois but is also a most popular choice with the home gardener. More tomatoes are grown in home gardens than any other vegetable.

One problem that both home and commercial gardeners face every spring is selection of the best tomato varieties. Already there are over 200 varieties from which to choose, and many new varieties are being added every year.

Commercial fresh market growers should select disease-resistant varieties that are adapted to a particular region. Other characteristics, such as earliness, plant type, fruit color, fruit size, and crack resistance also are important. For the home gardener, the chief characteristic to look for in a variety is a high degree of disease resistance so that tomatoes may be harvested over an extended period. Both market growers and home gardeners should continually try new varieties which may give improved performance in a particular location or under special cultural treatment.

A Cardinal tomato plant staked and pruned to two stems. Plants that are trained and pruned require less space, are somewhat earlier, and produce larger fruits than plants that are not trained. However, total yield per plant is reduced.

As an aid in choosing good varieties, the Department of Horticulture has been evaluating the more promising ones. Extensive tests have been conducted at Urbana, the Dixon Springs Experiment Station, and other University experiment fields, as well as on farms in important tomato-growing regions of the state. The varieties in the table are generally adaptable to varied Illinois conditions and are suitable for fresh market and home use. Special varieties are usually grown for processing and greenhouse production.

Some of the newer varieties listed in the table may not be available from local plant suppliers, and the plants may have to be produced at home. For more information on varieties or on plant growing write to the Department of Horticulture, University of Illinois, Urbana.

J. W. Courter is Assistant Professor of Horticulture and J. S. Vandemark is Professor of Horticulture.

Brief Description of Selected Tomato Varieties Suitable for Illinois

Variety	Principal use[a]	Plant type[b]	Fusarium wilt[c]	Fruit size[d]	Notes
		EARLY CROP			
Avalanche (F-1)	MG, HG	I	R	M	Trial only
Alpha 88 (F-1)	MG	D	S	S-M	Trial only
Cardinal (F-1)	MG, HG	I	S	L	
Cavalier	MG, HG	D	S	M	Trial only
Glamour	MG, HG	SI	S	M	Crack-resistant
Heinz 1350	MG, HG	D	R	S-M	Trial only
Moreton Hybrid (F-1)	MG, HG	I	S	M	
Sioux	MG	SI	S	S-M	
Surprise (F-1)	MG, HG	I	R	M	
		MAIN CROP			
Big Boy (F-1)	HG	I	S	L	
Homestead	MG, HG	I	R	M	
KC 146	MG, HG	I	R	M-L	Crack-resistant
Indian River	MG, HG	I	R	S-M	Resistant to several foliage diseases
Manalucie	MG, HG	I	R	L	
Manapal	MG, HG	I	R	L	
Wonder Boy (F-1)	MG, HG	I	S	L	
		SPECIAL PURPOSE			
Caro-Red	HG	I	S	S-M	High vitamin A
Jubilee	HG	I	S	M-L	Yellow fruit
Nemared	HG	D	R	S-M	Nematode-resistant
Red Cherry	HG	I	S	S	Very small
Roma VF	HG	I	R	S	Paste tomato

[a] MG — market garden; HG — home garden.
[b] D — determinate, or bush-type growth; I — indeterminate or vine-type, suitable for staking SI — semi-indeterminate.
[c] S — susceptible; R — resistant.
[d] S — small; M — medium; L — large.

RESEARCH IN BRIEF

The European Common Market for Grains: Issues and Implications

Negotiations to establish a European common market for agriculture have been difficult and protracted. The principal controversy has developed around grain prices.

Last November the Common Market Commission proposed that a single market for grain be established by July 1, 1964, instead of the originally scheduled date of 1970. Three price levels have been suggested: (1) *Target prices* are analogous to U.S. parity prices and are set at levels considered necessary to yield a desirable income to producers. (2) *Intervention* or *support prices* correspond to U.S. support prices. They are 5 to 10 percent below target prices and would be maintained by open market buying and selling. (3) *Threshold* or *import prices* are derived from target prices by subtracting the costs of moving imported grains from the port of entry to the center of the largest deficit area. Proposed prices for five grains are as follows:

	Price per ton		
Grain	*Target*	*Support*	*Import*
Wheat	$ 96.37	$ 89.57	$ 95.24
Rye	85.02	79.36	83.90
Barley	83.90	78.23	82.76
Corn	85.02	79.36	83.90
Durum	113.38	106.57	112.24

If this proposal is adopted, wheat prices will go up 8 percent in France and barley prices, 16 percent. Prices will also rise in the Netherlands— 6 percent for wheat and 15 percent for barley. By contrast, Germany and Italy will have to reduce their wheat prices by 16 and 11 percent. In general, farmers in Belgium, France, and the Netherlands are expected to benefit from the proposed price levels, while those in Germany, Italy, and Luxembourg will lose.

Even at prevailing price supports and grain acreage, grain production in member countries, especially France, would continue to expand, according to recent studies by the EEC and FAO. The prospective raising of French grain prices is expected to increase production even more and to reduce demand for imports from lower cost sources, principally the United States. The price increase may also restrain consumption, widening the gap between production and domestic utilization. Moreover, holding prices above equilibrium level will further distort resource allocation, cause burdensome inventories and storage problems, and lead to pressure for surplus disposal programs. All things considered, adoption of the proposed price levels would work against the best interests of both producers and consumers.

While it is unrealistic to expect that EEC will abandon its agricultural protectionism, the United States must try to secure a share of the European market. The so-called Kennedy round of trade negotiations, scheduled to begin in May under GATT auspices, will provide an opportunity for exploring possible arrangements for market access and for broadening the scope of international cooperation. —*S. C. Schmidt*

Farm Families Are Older and Smaller Than in Past

In 1960 there were 152,250 families on Illinois farms. Of these, 141,580 consisted of husbands and wives living together with or without their own children. The remaining included 5,622 families headed by a male other than the husband and 5,148 headed by females.

Farm families, more than other families, followed the traditional "normal" pattern of husband and wife, with or without children at home. In 1960, 92.9 percent of the farm families fell into this category, as compared with 91.6 percent and 86.9 percent for rural nonfarm and urban groups. Only 3.5 percent of farm families had female heads as compared with 6 percent of rural nonfarm families and 9 percent of urban families.

No longer are the largest families on farms. In 1960 farm families, averaging 3.62 persons, were slightly smaller than rural nonfarm families, which averaged 3.65. Urban families averaged 3.55 persons. As cultural differences between farm and other groups tend to merge and disappear, farm families are approaching other families in size and structure.

A significant factor in the decreasing average size of farm families is the ages of heads of husband-wife families. Three-fifths of the men heading farm families were over 45 years of age and only one-sixth were under 35 years. By comparison about one-half of the rural nonfarm and urban families were headed by males older than 45 and about one-fourth by men under 35. Husbands in Illinois farm families averaged 49.4 years; wives, 45.5 years. In urban and rural nonfarm families, average ages were 44.4 years for husbands and 41 years for wives.

While husband-wife farm families had 197,535 children under 18 years of age, and 33,796 older than 18, 46.8 percent reported that none of their own children lived at home. At present the no-child family is more prevalent in farming areas than in either rural nonfarm or urban areas, where the proportions of families with no children at home were 42.6 and 45.2, respectively. With decreasing numbers of children under 18, most farm families are approaching the all-adult stage.

Gauged by the number of other relatives, the farm family continues to be a strongly knit kinship group. In addition to husbands and wives and their own children, there were 1,863 grandchildren; 6,676 parents of either the husband or the wife; 1,782 sons-in-law and daughters-in-law; 6,678 brothers and sisters of either spouse; and 1,099 other rela-

tives living in rural families. The general kinship structure of the farm family has been an important force in nurturing the values associated with family life. Undoubtedly this kinship structure also plays an important role in socializing the individual members and particularly in transmitting cultural values to the young. — *C. L. Folse*

Abilities, Plans, and Needs of Rural High School Students Are Subject of Pilot Study

A pilot study of the educational and vocational needs of rural high school students was conducted at Sullivan in the spring of 1963. The study included 160 juniors and seniors.

Results of tests on verbal reasoning, abstract reasoning, natural and social science reading, and writing were taken from the Illinois High School Testing Program and were supplemented by tests on mechanical aptitude and personality qualities. To these were added data on social and economic environment and occupational and educational aspirations. The data were analyzed to see if there are any differences between those planning to go to college and those not planning to go.

Of the 160 students, 84 or 52 percent planned to go to college. This number included almost three-fourths (72.9 percent) of the boys, but less than half (41.3 percent) of the girls.

Verbal and abstract reasoning scores were significantly higher, on the average, for those going to college than for those not planning to go. The same was true, also, of scores for natural science and social science reading and for mechanical aptitude.

These young people differed also in personality characteristics. Boys who planned to go to college were above average in enthusiasm and talkativeness; those who did not plan to go to college were more insecure and anxious than average. Girls who planned to go to college were above average in being bright and intelligent, enthusiastic and talkative, and sensitive and affirmative. Those not planning on college were more submissive and mild, timid and shy, and conservative and accepting than the average.

This pilot study was designed to test research tools which are to be used in an extended study of rural high schools in at least 8 (hopefully 22) counties. If findings from the larger sample are like those from the pilot study, further study is justified on the special educational and vocational needs of rural students not planning to go to college. — *D. E. Lindstrom*

Lambs' Ration Utilization While Receiving Compound for Parasite Control

A major obstacle to the optimum performance of sheep continues to be parasites, especially internal roundworms. In recent years the drug industry has developed several promising drugs for the control of parasites. Phenothiazine, introduced during World War II, was the first of these drugs, offering certain advantages over the commonly used "cunic" (copper sulfate-nicotine sulfate), which had been the standard treatment until that time. More recently certain organic phosphates have shown promise in control of some internal parasites in sheep and cattle.

Before a new drug is adopted for use, many factors must be considered. Major emphasis has been placed on the drug's effectiveness and the safety both of the animals which are treated and of the people who consume products from treated animals. Another important factor is sometimes overlooked. This is the effect of the drug on the nutritional status of the animals. Since the economic performance of ruminants depends on optimum conditions in their rumens, it is wise to examine the effects of oral medication on digestibility of ration dry matter and retention of nitrogen.

This has been done with an organic phosphate known as O,O-diethyl O-3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl phosphorotioate, which has been used with some success in treating internal parasites. Two different trials have been conducted, Trial 1 involving 16 feeder lambs and Trial 2, 24 lambs. Before the trials, all lambs were treated to remove parasites, so that possible side effects of the drug could be measured.

The basal ration, which was pelleted to prevent separation of the ingredients, consisted of ¼-inch cut sun-cured alfalfa, 50 percent; ground corn, 35 percent; soybean meal, 13 percent; steamed bone meal, 1 percent; and trace-mineralized salt, 1 percent, plus 7.5 mg. of tetracycline antibiotic per pound of ration.

In each trial, part of the lambs received 20 parts per million of the organic phosphate. Effects on dry-matter digestibility and nitrogen retention were as follows:

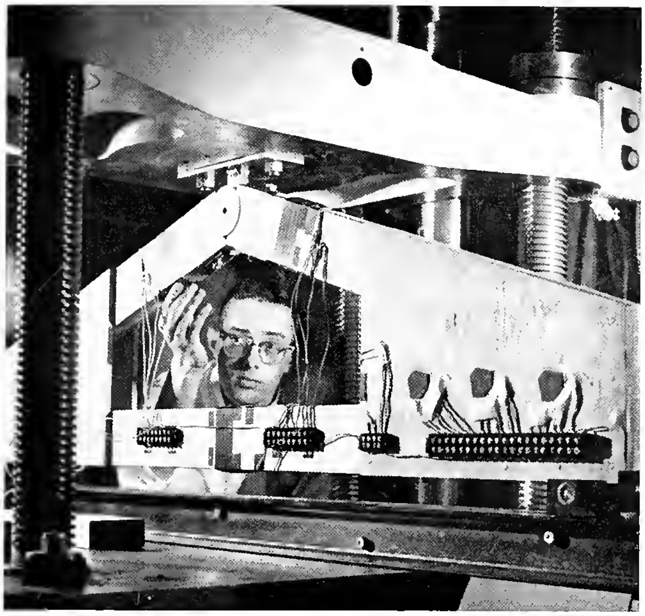
	D.M. digestibility, %	*N. retention, gm.*
Trial 1		
Control lambs . .	58.8	5.2
Treated lambs . .	59.4	4.3
Trial 2		
Control lambs . .	69.2	8.2
Treated lambs . .	69.8	9.8

None of these differences were statistically significant. It seems, therefore, that this compound could be fed in a finishing ration for a short time without significantly influencing the lambs' utilization of the ration. — *U. S. Garrigus, E. E. Hatfield, and B. B. Doane*

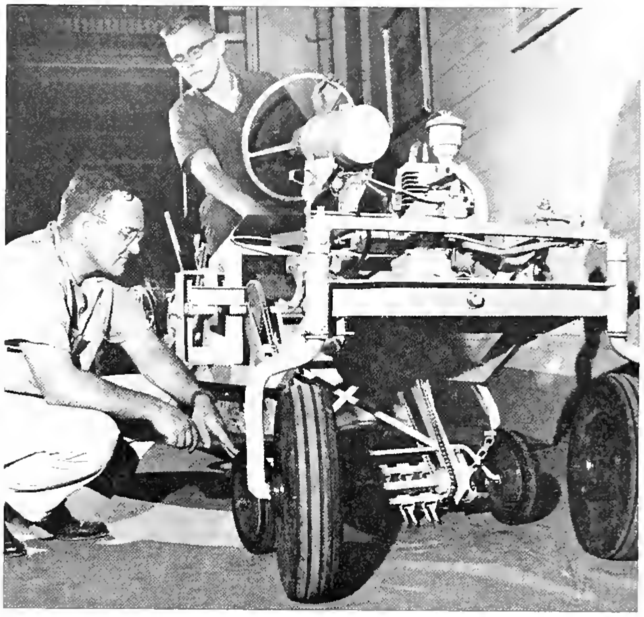
Improved Design Methods for Glue-Nail Trusses

A trussed roof increases the convenience of a farm building, costs no more than a conventional framing system, and may be prefabricated in a shop and quickly erected.

Glue-nail trusses are constructed from dimension lumber with connections of plywood gusset plates that are simultaneously glued and nailed. These trusses exhibit superior strength and stiffness, but they are somewhat difficult to design. Because the joints are rigid it is hard to accurately predict the stresses in the



The strength of glue-nail truss joints is tested by using small triangular frames with plywood gusset plates like those of a truss. Here one of the test frames is loaded in a universal testing machine.



This experimental machine has been developed for research on mechanical harvesting of strawberries. Among the things that need to be determined are the best size and shape for the fingers on the combing device, and the proper finger spacing.

members when the truss is loaded. The analysis now in use involves many hours of tedious calculations and the results are only approximate.

Another problem is that little is known about the strength of the plywood joints. The standard design procedure is based on rather crude assumptions that have not been verified experimentally.

The strength and behavior of glue-nail truss joints are now being studied in the Department of Agricultural Engineering. The work has been restricted to the joint at the eave of the roof, because it is most susceptible to failure and is generally the weak point of the truss. It would be inconvenient and costly to build a complete truss to test one joint, so a small triangular frame with plywood gusset plates like those of a truss is being used. The joints are tested by loading the frame in a universal testing machine.

Stresses in the plywood of the joint will be determined qualitatively by the brittle coating method, and quantitatively with wire resistance strain gages. Finally, the test frame will be loaded to failure to determine the strength of the specimen joints. It is hoped that the results will lead to a more efficient method of design.

A related study concerns the method of computing stresses in the members of glue-nail trusses and is aimed at developing an easier and more accurate method than the one now in use. — *J. D. Bradley*

Mechanical Harvesting of Strawberries Is Investigated Since Labor Is Scarce

Strawberries have one of the largest cash values of all fruits and vegetables grown in the United States. Oranges, apples, grapes, lettuce, and tomatoes are the only fruits and vegetables that exceed strawberries in value. The yearly strawberry crop in the United States is worth nearly \$100,000,000. Almost \$100,000 worth of strawberries is sold annually in Illinois.

Hand labor for jobs such as picking strawberries is rapidly increasing in cost, while the price the grower receives is nearly constant. The cost of hand labor is not the only problem involved. It is becoming increasingly difficult to obtain hand labor at all. Mechanization of strawberry harvesting therefore seems a worthwhile project. Work has already been done on mechanical harvesting of the five fruits and vegetables mentioned above.

The value of a stripping or combing device for harvesting strawberries is now being investigated in the Agricultural Engineering Department. The objectives of the study are (1) to determine the physical fruit and fruiting characteristics of the strawberries, (2) to develop mechanical equipment based on these characteristics, (3) to field-test the equipment. At present, studies are being made to determine the best size and shape of the fingers on the combing device and the proper finger spacing.

The Horticulture Department is working to inbreed the characteristics considered desirable for mechanical harvesting. This project, like many others, must be a cooperative effort. A machine would be of little value if the crop wasn't adaptable to the machine. As in constructing a bridge, you don't build entirely from one side, but rather work from two directions to reach the final goal. — *Dean L. Hoag*

FARM BUSINESS TRENDS

Our nation's cattle industry has been dominated by cyclical swings for nearly a century. There are cycles in numbers of cattle and calves, in slaughter, and in prices. The swings have been quite regular and predictable. Consequently frequent study of the cattle cycles can help cattlemen make plans for successful operations.

The big decline of cattle prices from late 1962 to early 1964, like many before it, was caused mainly by cyclical changes within the cattle industry itself. The charts show the main features of the cattle cycles since 1910.

The latest buildup in cattle numbers has been underway for six years. During this time farmers and ranchers have added more than 15 million cattle and calves to their herds — nearly 3 million a year.

The total slaughter of cattle and calves combined has not increased, but has held at about 34 million annually. The slaughter of calves, however, has decreased from 10 million to 7 million while the slaughter of cattle has gone up from 24 million to 27 million. Average slaughter weights of cattle slaughtered also increased, partly because of a decrease in cow slaughter and a large increase in the number of fed steers and heifers slaughtered.

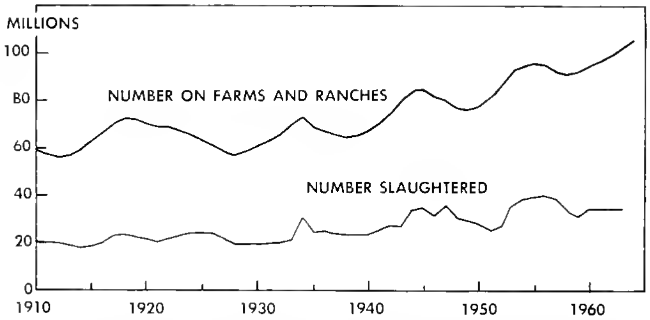
Total beef output increased from 13.3 billion pounds in 1958 to 16.5 billion pounds in 1963. The output of steer and heifer beef increased from 9.7 billion pounds in 1958 to around 13.6 billion pounds in 1963. Nearly half of these increases came in 1963.

Imports of beef increased from 0.9 billion pounds (carcass weight equivalent) in 1958 to near 1.8 billion pounds in 1963. About two-thirds of this increase came in 1962. Most of the imported beef is lean meat that is similar in quality and uses to our cow beef. The increase in beef imported in recent years has just about offset the decrease in our own output of cow beef.

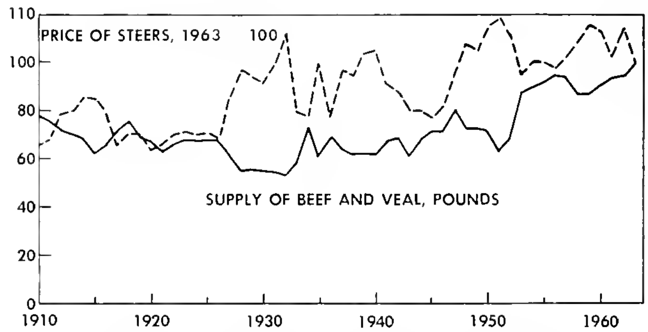
The supply of beef and veal combined increased from 87 pounds per person in 1958 to over 100 pounds in 1963. More than half of this increase occurred last year.

The sharp increase in beef supplies in 1963 brought a reduction in cattle prices much like those that occurred on several earlier occasions.

Looking ahead, it appears that the slaughter of cattle will be increased by as much as 10 percent in a very few years. There may be some reduction in average slaughter weights, but the output of beef will likely be large enough to keep prices of fed cattle well below the levels of recent years. — *L. H. Simerl*



Total number of cattle and calves on U.S. farms January 1, and number slaughtered annually, 1910-1963. Cattle numbers increase in waves, and slaughter increases after each buildup in numbers.



Supply of beef and veal per person in the United States, and price of steers adjusted to reflect relationship with prices of other farm products (1963 relationship = 100). Short-time price changes largely reflect changes in supply. The long-time upward trend is due mostly to increasing consumer demand.

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IN THIS ISSUE

Lamb in metabolism unit becomes a biological instrument for measuring the relative value of nonprotein nitrogen as influenced by other dietary components (page 6).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell . . . . Associate Director

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NEWS AND VIEWS

(With this issue, Dr. M. B. Russell, Associate Director of the Experiment Station, begins a regular column in Illinois Research)

Dixon Springs. A basic reorganization of the Dixon Springs Experiment Station went into effect July 1. Purpose of the change was to meet the research needs of southern Illinois more completely and to utilize more fully Dixon Springs' unique facilities for field research. Professor R. J. Webb, who has been designated Assistant Director of the Illinois Agricultural Experiment Station, will continue to administer the facilities and coordinate all of the work at Dixon Springs. Each of the other academic staff has become a member of one of the subject-matter departments of the University. This way, each department will be responsible for all staff and research in its subject-matter area, whether the work is done at Dixon Springs, Urbana, or elsewhere.

On the wing. As further indication of the international dimension of the Experiment Station's work, several staff members have recently traveled to other parts of the world. Professors G. K. Brinegar and T. A. Hieronymus of the Department of Agricultural Economics spent January and February in Japan on a preliminary study of the role of agriculture in the recent remarkable economic growth of that nation. Professor A. L. Hooker of Plant Pathology participated in the European Corn Research Conference in Vienna, Austria. And Professor K. E. Harshbarger of Dairy Science traveled to Bankok, Thailand, to take part in an international nutrition conference.

Water. Recognizing water as a vital natural resource, the University of Illinois has established a Center for Water Resources. This unit will encourage and coordinate research in all areas of the University, as well as in the state scientific surveys and federal research agencies located on the campus. Several existing Experiment Station studies will constitute an important part of the center's program.

Is Multiple Farrowing Better Than a Two-Litter System of Hog Production?

ALLAN G. MUELLER

MANY HOG PRODUCERS are asking whether they should stay with the two-litter system of hog production, or shift to a multiple-farrowing system.

The two-litter system, in which one group of sows farrows at 6-month intervals, is the logical result of the necessary production time. About 6 months are required from farrowing to market, about 10 months from breeding to market.

Multiple-farrowing systems may be described as more than one group of sows with farrowings scheduled at four, six, eight, or more periods during the year. For example, three groups of sows, farrowing at rotating 2-month intervals, may be called a six-litter system.

Changes in farrowing pattern

As shown in the chart, the traditional March-September farrowing pattern has changed in recent years. During the 10-year period from 1953 to 1963, Illinois farmers reduced farrowings in March, April, and May, and increased farrowings in the summer and winter. One desirable result of this shift is a more even flow of butcher hogs to market.

I believe that two major factors account for this shift in farrowing patterns: (1) the continuing trend toward increased use of confinement and specialized hog buildings, and (2) the increased intensity of hog production on specialized farms. These two factors are closely related. Once the specialized buildings are erected, cost considerations put pressure on the farmer to keep the buildings filled to capacity the year round.

Farmer experiences

Illinois farms producing 30 or more litters of hogs annually in 1960 and 1961, were studied in the Agricultural Economics Department. The principal objective was to observe farmers' experiences with different systems and sizes of multiple-farrowing operations.

Data about these farms were obtained from feed and production records in the farm record books and from farmers' answers to questions about production practices.

As shown in Table 1, most of the larger hog-producing farms used either a multiple-farrowing system or a modification of the two-litter system. Of the farms with a conventional two-litter system, two-thirds produced fewer than 60 litters. By comparison, 17 out of 23 farmers with sows farrowing six or more times a year, produced 100 or more litters annually.

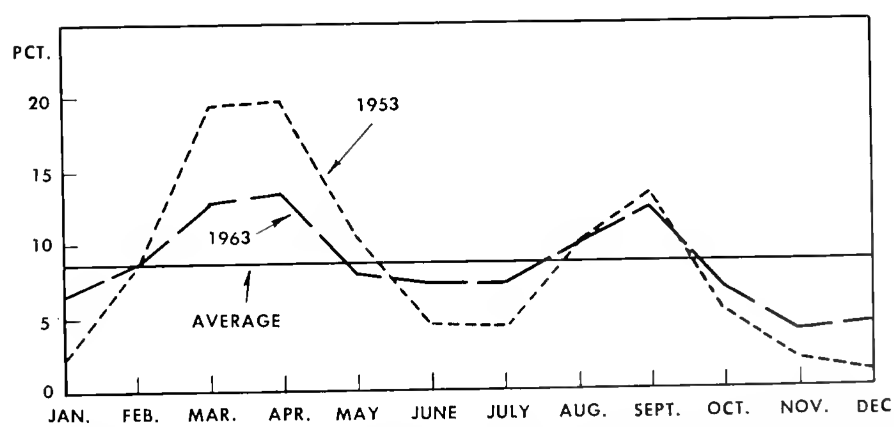
When each system of farrowing was considered separately, size of hog enterprise did not significantly affect the number of pigs weaned per litter, death losses after weaning, feed conversions, or feed costs per 100 pounds of pork produced.

Further comparisons were made among different farrowing systems (Table 2). Farms with two or four farrowing periods averaged 86 litters a year, while those with six or more farrowing periods averaged 155 litters.

Pigs weaned per litter averaged the same on both groups of farms. However, death losses were higher on the farms with six or more farrowing periods than on the other farms. We also found significant differences in the amount and cost of feed required to produce 100 pounds of pork.

On farms using two- and four-litter programs, 419 pounds of feed, costing $9.98, were required to produce 100 pounds of pork. On farms with six or more farrowing periods, 443 pounds of feed were required at a cost of $10.33.

Explanations for the differences in feed requirements and costs were not apparent from the data. In a multiple-farrowing operation, however, the frequent farrowing periods and the wide range in age of hogs on the farm at any one time may severely tax the farmer's ability to control diseases, parasites, and stress.



Litters farrowed each month on Illinois farms, 1953 and 1963, expressed as percent of year's total. Monthly variations are much less now than they were 10 years ago. As a result, there is a more even flow of butcher hogs to market.

If health problems are indeed greater in the multiple-farrowing programs, this would account for the higher death loss associated with larger numbers of farrowings.

Labor and building costs

Labor requirements for hog production are not evenly distributed over the 6-month production period. About half the work comes during farrowing and weaning. Thus, on the typical Illinois crop-hog farm, with hogs farrowing in February-March and again in August-September, the peak labor requirements for hogs coincide with the slack labor periods of crop production.

On specialized hog farms, however, crops need not compete with hog production for labor. Farmers with intensive hog-producing programs may therefore switch to a multiple-farrowing system in order to even out the seasonal labor requirements.

The choice of building facilities also affects the decision to use multiple farrowings. On farms with confinement buildings, one farrowing house can be used for six or more farrowings a year. One rearing and finishing building will handle only two, or under ideal conditions, three groups of pigs a year. By adding nursery and pre-finishing buildings to supplement the finishing buildings, however, a producer can use the farrowing house to capacity. Such a program offers opportunities for savings in building costs per pig produced.

Possible savings are illustrated in Table 3, which gives some estimated building and equipment costs for different farrowing systems. If the farrowing house and finishing building were used for only one farrowing a year, total investment per pig produced would be $83.75. Using the same buildings for two farrowings a year would cut the investment per pig in half. If the farrowing house were used for six litters a year and were combined with a nursery house, pre-finishing building, and finishing building, the total investment per pig would be only $20.62.

The cost savings from the multiple-farrowing programs are largely due to the use of one farrowing house for several farrowings a year, and to the use of nursing and pre-finishing buildings that are scaled to the size of the growing pig.

Seasonal prices

If only seasonal variations in hog prices were considered, farrowing schedules might be planned to have hogs ready for market when prices are expected to be highest. Normally market prices are at their peak in June, July, and August, although individual years may vary from the seasonal pattern.

Despite the importance of seasonal price ranges in planning farrowing schedules, they should not be overemphasized for two reasons: (1) Accurately predicting hog price variations 10 months or more in advance (breeding to market) is not a precise science. (2) Efficient use of labor, buildings, and equipment is probably more important to profits than planning farrowings so that hogs can be marketed at a predicted seasonal high price.

Importance of manager

The manager, not the production system or the farrowing pattern, determines the degree of success of a hog operation. This observation comes from years of studying farm records and observing successful hog producers in Illinois.

The choice of a farrowing program for a particular farm depends on many factors. They include available labor supply, buildings already on the farm and buildings needed, seasonal ranges in hog prices, and the management problems connected with the more intensive systems.

On a typical one-man corn-hog farm, the conventional two-litter system may be hard to beat. But if unused labor or specialized hog facilities are available on your farm, a multiple-farrowing system may smooth out peak labor periods, permit more complete use of hog buildings, expand hog volume, and add to net farm income.

Table 1. — Distribution of Farms by Size of Enterprise and by Farrowing System, 1960

Number of litters farrowed	Number of farrowings: 2	2[a]	4	6 or more	All farms
	number of farms				
30- 59	41	28	11	2	82
60- 99	14	40	30	4	88
100-149	5	24	15	9	53
150+	2	17	3	8	30
All farms	62	109	59	23	253

[a] Modification of two-litter system. The farrowing period was extended for more than one month.

Table 2. — Performance Factors on Farms With Different Systems of Farrowing, 1960-1961

Performance factor	Number of farrowing periods: 2 and 4	6 or more
Number of farms		
1960	230	23
1961	147	50
Average number of litters farrowed	86	155
Pigs weaned per litter	7.4	7.4
Percent death loss	1.4	1.8
Pounds of feed per 100 pounds produced		
Grain	355	372
Commercial feeds	64	71
Total[a]	419	443
Feed cost per 100 pounds produced	$ 9.98	$ 10.33
Cost per 100 pounds commercial feeds	5.18	4.92

[a] Difference significant at 5 percent.

Table 3. — Building and Equipment Investment per Pig Produced With Different Farrowing Systems[a]

Type of facility	No. of farrowings per year: 1	2	4	6
	investment per pig			
Farrowing house	$43.75	$21.88	$10.94	$ 7.29
Nursery house	. . .	. . .	. . .	3.33
Pre-finish bldg.	. . .	. . .	5.00	3.33
Finishing bldg.	40.00	20.00	10.00	6.67
Total	83.75	41.88	25.94	20.62

[a] New construction costs figured on basis of 32 sows per farrowing period and 8 pigs weaned per litter.

Allan G. Mueller is Associate Professor of Farm Management, Department of Agricultural Economics.

Are Fertilization and Irrigation Worthwhile for PINE TREES?

A. R. GILMORE

NEITHER fertilization nor irrigation of pines is advocated at present on a commercial scale, but research workers in forestry are doing both.

Even though numerous investigations have been conducted in the past, confusion still exists as to the effects of fertilizers and water on the growth of trees and on the wood produced. To clarify these numerous findings, the Department of Forestry is studying the effects on pines of various rates of fertilizers, water, and combinations of the two. The study is being conducted in an 18-year-old loblolly pine plantation at the Dixon Springs Experiment Station.

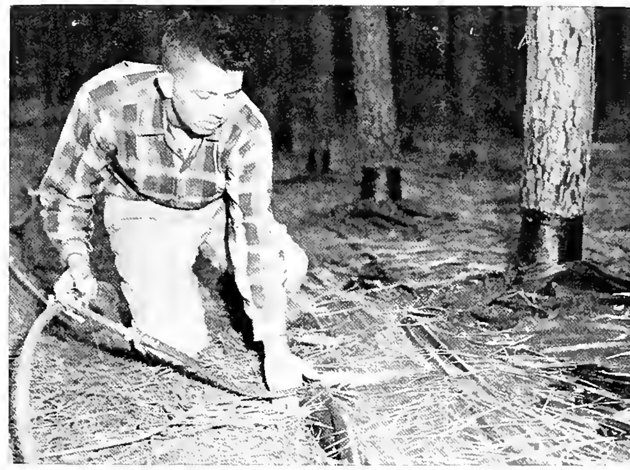
Fertility is easy to control, but control of soil moisture is quite a different matter. To prevent lateral movement of moisture and to contain the roots of trees in each 1/20-acre plot, trenches 3 feet deep were dug around the plots. (The soil is characterized by a hardpan at 2 feet.) The trenches were lined with plastic before being filled with sand. On some plots it was desirable to keep the soil very dry. To do this, plastic was fitted snuggly around each of the nearly 40 trees on a plot.

With covers and irrigation, soil moisture is being controlled so that one of the following conditions is replicated three times: Moisture is (1) maintained near field capacity in spring and near drouth conditions during summer; (2) maintained under drouth conditions during spring and near field capacity during summer; (3) always maintained near field capacity; (4) brought back to field capacity by irrigation when 30 percent of the available moisture has been used; (5) brought back to field capacity when 60 percent of the available moisture has been used; and (6) uncontrolled, receiving only normal rainfall.

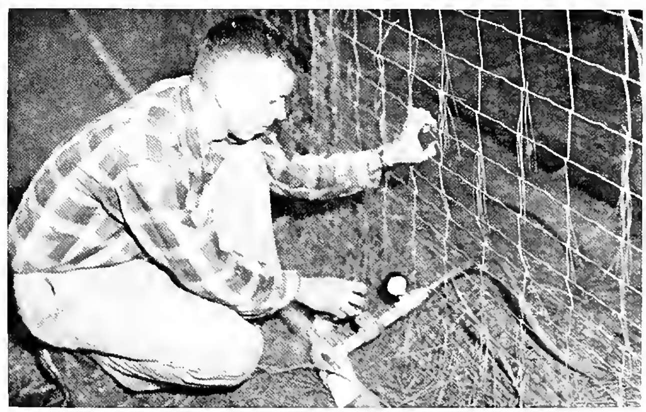
Some growth features being studied are diameter and height of the stem, length of needles, rate of growth, and variability of growth. The anatomical features being studied are specific gravity, tracheid length, springwood, summerwood, cellulose, extractives, lignin, cell size, and cell wall thickness.

Effects of irrigation and fertilization on growth and some of the wood characteristics can be determined at the end of each year. When the study is ended four years hence, some of the trees will be felled to determine the influence of these controlled environmental factors on the anatomy of pine wood.

A. R. Gilmore, Assistant Professor of Forestry, is stationed at the Dixon Springs Experiment Station.



Plots 1/20 acre in size are covered with plastic to keep off rain. Plastic is fitted snugly around trees, and irrigation hose is laid under the plastic.



An 8-foot wire fence keeps deer out of the plastic-covered plots. Note irrigation pipe and gauge.

An electric pump is used to bring water from the 1½ million-gallon pond. Pines in background are 45 feet tall.

PINCH-HITTING FOR PROTEIN

Urea and alfalfa meal, with DES implants, can cut $20 a ton from the costs of protein supplement for sheep and cattle

U. S. GARRIGUS, M. R. KARR, E. E. HATFIELD, and H. W. NORTON

Chemical analyses, as well as lamb performance, are necessary to rate value of rations. Critical evaluations were made of ratios and levels of volatile fatty acids; amounts and forms of blood nitrogen; and chemical balances of specific nutrients. Here T. R. Cline, graduate assistant, does an analysis.

LAMB PRODUCERS, and cattle feeders too, have found it increasingly difficult to make a profit in recent years. The competitive situation being what it is, the economic pressure will no doubt continue.

A feeder cannot easily follow the old business rule, "Buy low and sell high." He can more readily control other factors in his operation, such as the unit cost of his product. One way of reducing costs is to formulate improved rations. Another way is to use lower cost ingredients wherever possible.

Urea furnishes nitrogen

Since protein is one of the highest cost ingredients in a finishing ration, it is one of the most logical places to seek a reduction in ration costs. The unique nutritive material in protein is nitrogen. And nitrogen may be obtained from nonprotein sources, such as urea, less expensively than from proteins like soybean, linseed, and cottonseed meals.

Sheep and other ruminants have unusual capability for utilizing nonprotein nitrogen (NPN). Their rumens act as built-in "fermentation vats" where microorganisms can metabolize roughage and relatively simple chemicals like urea, and from them form proteins, vitamins, and other substances that the animals need to perform well. Urea, then, might reduce ration costs if it were efficiently utilized.

The first research workers to report on the utilization of urea by sheep were Harris and Mitchell (1941), of the University of Illinois. In early experiments, utilization of urea was very poor, because relatively little was known about the chemical and physical conditions necessary for bacterial synthesis of protein in the rumen. Scientists both at Illinois and elsewhere have continued to study the effects of various nutritives and management practices on the utilization of NPN by ruminants. As a result, the processes involved in nitrogen utilization are now much better known.

Alfalfa and DES aid utilization

Since the early 1900s, when Coffey, working at Illinois, established corn and alfalfa as a standard finishing ration for lambs in this country, alfalfa has been widely used in ruminant rations.

To have withstood the test of time, alfalfa must contain nutrients that are particularly helpful in utilizing corn and some other concentrates in finishing-type rations. Burroughs (1950) found that alfalfa increases microbial growth in the rumen and improves utilization of corncobs, which are mainly cellulose. Greater microbial growth could hasten the synthesis of NPN into microbial protein, thus improving its utilization.

Other studies have shown that nitrogen retention is increased by diethylstilbestrol (DES) either fed or implanted. West Virginia scientists further found that DES reduces the time needed for a ruminant to adjust to urea nitrogen. In Illinois experiments, urea was better utilized when included in a complete self-fed ration than when fed periodically.

Thus, there is good reason to believe that alfalfa, DES, and self-feeding all improve the utilization of urea in present-day finishing rations.

Recent investigations

Experiments are continuing at Illinois on ruminants' utilization of nitrogen from different sources, and on the effects of DES and alfalfa.

The main objectives of one experiment were to compare soybean meal, urea, and biuret as nitrogen supplements in lamb-finishing rations, and to determine the effect of various ration components and DES implants on the utilization of nitrogen from these sources.

Black-faced northwestern lambs were used. They included 72 lambs used in metabolism trials, and 12 lots of 12 lambs each, for feedlot and carcass evaluation. They were self-fed the rations shown in Table 1. Six lambs in each lot were implanted under the skin of the ear with 3 milligrams of DES.

Many criteria for evaluating treatment effects were used. However, only those of most importance to the lamb producer are presented here. Data on heat treatment of corn and on utilization of biuret are not included in this discussion.

As shown in Table 1, dehydrated alfalfa meal ("dehy") was partially substituted for dehydrated ground corncobs in half of the rations. Primary sources

U. S. Garrigus is Professor; M. R. Karr, Assistant; E. E. Hatfield, Associate Professor; and H. W. Norton, Professor of Statistical Design and Analysis; all in the Animal Science Department.

Table 1. — Percentages of Different Ingredients in Rations[a] (1962-63 experiment)

Ingredient	Lot 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12
	percent					
Corn, cracked[b]	35.0	50.0	49.5	43.5	51.5	51.2
Corncobs, dehydrated, ground	40.0	40.0	40.0	20.0	20.0	20.0
Alfalfa meal, dehydrated				20.0	20.0	20.0
Soybean meal, 50% C.P.	18.0			9.5		
Urea (262)		3.0			1.5	
Biuret, pure			3.5			1.8
Molasses, cane	5.0	5.0	5.0	5.0	5.0	5.0
Bone meal, steamed	1.2	1.2	1.2	1.2	1.2	1.2
Salt, trace mineralized	0.5	0.5	0.5	0.5	0.5	0.5
Sulfur, elemental	0.3	0.3	0.3	0.3	0.3	0.3
Vitamin A and D[c]	+	+	+	+	+	+

[a] The twelve rations consisted of 60 percent concentrates and 40 percent roughage with a crude protein equivalence of 13.55 ± 0.5 percent.
[b] Lots 1 through 6 regular cracked corn, and Lots 7 through 12 steamed cracked corn (treated with steam after cracking for about 10 minutes at 190° F.).
[c] Vitamin A at 370 I.U. per pound and vitamin D at 46 I.U. per pound of ration added as Quadrex.

of nitrogen (soybean meal and urea) were reduced in the rations containing "dehy," so that all lambs would receive about the same amount of nitrogen.

Daily gains were 75 percent faster for lambs receiving "dehy" than for the others (0.42 versus 0.24), and carcasses were about a third of a grade higher (Table 2). In addition, the "dehy"-fed lambs required 41 percent less feed to put on a pound of gain. The reduction in feed required for a pound of gain was 21 percent for lambs fed soybean meal in addition to alfalfa meal, and 38 percent for those getting urea.

Substituting alfalfa meal increased the rate of gain by 43 percent when soybean meal was a source of additional nitrogen; and by 130 percent when urea was fed.

Implanting lambs with DES increased daily gains by 44 percent (0.27 versus 0.39, Table 2) and increased carcass grades by about one-third of a grade.

DES implants had the greatest effect on lambs receiving urea and "dehy." Average daily gain was increased from 0.31 pound to 0.47 pound, or 52 percent. The increase for lambs receiving soybean meal and "dehy" was 31 percent.

The combined effects of "dehy" and DES implants increased gains by 262 percent when lambs were fed urea. Carcass grade was increased by one full grade. For lambs fed soybean meal, the increases were 122 percent for rate of gain, and one-third of a grade.

Last year, a supplement containing 14 percent urea, 81 percent "dehy," and 5 percent molasses was substituted, pound for pound, for 50-percent soybean meal. DES-implanted lambs consuming the "dehy-urea" gained 13 percent faster than implanted lambs on soybean meal (0.52 versus 0.46 pound a day). DES improved gains by 30 percent for lambs receiving "dehy-urea," but only 8 percent for lambs receiving soybean meal.

Table 2. — Lamb Gains and Carcass Grade as Affected by Roughage Source and Stilbestrol Implants and Their Interrelationships With Nitrogen Source

Ingredient evaluated	No. of lambs	Av. daily gain, lb. Live	Av. daily gain, lb. Carcass[a]	Carcass grade[b]
Corncobs, dehydrated ground	71	.24	.15	18.7
Alfalfa meal, dehydrated	72	.42**	.27**	19.5**
Control	72	.27	.18	18.6
Diethylstilbestrol[c]	71	.39**	.23**	19.4**
SBM[d] + dehy[e] + DES[c]	12	.51	.31	20.1
SBM + dehy − DES	12	.39	.26	19.0
SBM − dehy + DES	12	.40	.23	18.7
SBM − dehy − DES	12	.23	.15	18.5
Urea + dehy + DES	12	.47	.30	20.7
Urea + dehy − DES	12	.31	.23	19.3
Urea − dehy + DES	12	.21	.13	19.3
Urea − dehy − DES	12	.13	.10	17.5

[a] Carcass gains = (Chilled carcass weight − 47 percent × initial weight) / (Number of days on test (78))
[b] Average good = 17, high good = 18, low choice = 19, average choice = 20.
[c] Three-milligram diethylstilbestrol implant.
[d] Soybean meal (50 percent crude protein).
[e] Dehydrated alfalfa meal (17 percent crude protein).
** Significant at the 1-percent level.

Economic potential

On the basis of current prices, supplement costs can be reduced about one-third by feeding a "dehy-urea" supplement.

According to the American Feed Manufacturers Association, sheep and cattle being fed for slaughter consumed 20,000 tons and 1,863,000 tons of protein supplement, respectively, in 1962-63.

The use of "dehy-urea" with DES could mean an annual saving of $200,000 to sheep producers, if we make these assumptions: (1) That "dehy-urea" would supply the total protein supplement for one-half of the animals fed for slaughter; (2) that there would be equal rate of gain and carcass grade; (3) that the difference in cost is $20 a ton. Making the same assumptions, the savings for finishing cattle would be $18.6 million.

Putting results into practice

Often in the past, people have gone overboard in applying research findings to practical situations. A word or two of caution therefore seems appropriate here.

- DES should not be used with breeding animals.
- Urea must be well-mixed in the total ration to obtain the most suitable results.
- Nitrogen utilization is usually better with self-feeding or full feeding of urea-containing rations than with periodic limited feeding.
- Molasses may or may not improve NPN utilization. It does cut dust.
- Concentrates other than corn-and-cob meal have not yet been tested.
- As research continues, more precise information can result in more efficient formulations.

Standards for Judging Apple Quality

R. V. LOTT

APPLES at their best are a rare taste treat. But the ones we buy are often a disappointment. If we are to enjoy the delectable flavors that apples can possess, some knowledge of how to select and handle them is essential. Most of all, we need to know what constitutes satisfactory quality.

The term "quality" when referring to foods should be restricted to their edible desirability, that is, the extent to which they satisfy both physiological and psychological needs. It should not be used to refer to appearance, although appearance characteristics, such as color, are associated with degree of quality. Neither should quality be confused with condition, which correctly refers only to presence or absence of damage caused by insects, diseases, or physiological disorders.

Fortunately, in the apple and most other deciduous fruits, those constituents that are most important physiologically are also most effective psychologically. Therefore, apple quality can be considered from the standpoint of palatability.

Quality in apples is made up of flavor and texture. *Flavor* is the combination of the two tastes, sweet and sour, with aroma or smell. Several aromatic compounds combine in various ways to give each variety its characteristic aroma. *Texture,* which is felt as the fruit is chewed, is described by such terms as hard, firm, mealy, tough, coarse, and juicy.

The degree of quality in fruits can be described by the long-established horticultural terms *poor, fair, good, very good,* and *excellent.* In addition, the author has developed the following terms to designate degrees of quality from the standpoint of consumer acceptance: *1. Unacceptable,* a low degree of quality that results in only occasional purchases and no repeat purchases; the equivalent of very poor to poor quality. *2. Acceptable,* a degree of quality that causes moderately frequent initial and repeat purchases; the equivalent of fair plus to good. *3. Satisfactory,* a degree of quality high enough to stimulate frequent initial and repeat purchases; the equivalent of good plus to excellent.

Physiological changes

Since 1940, the author has investigated the physiological changes that occur in fruits during maturation and ripening. The objective has been to develop quality standards that will keep low-quality fruits off the market, and insure relatively uniform quality within each package.

In this discussion the term *maturation* refers to the process by which a fruit achieves *maturity* and is then *mature;* these terms describe the preharvest life of the fruit. The term *ripening* refers to the process by which a fruit reaches *ripeness* and is then *ripe;* these three terms are confined to post-harvest changes. *Handling* embraces everything that is done to or with the fruit from picking to consumption. The fruit is in some sort of *storage* environment from the time it is picked until it is consumed.

The stage of maturation at which an apple is picked has more influence upon its quality when it reaches the consumer than does any other production or handling factor. Only well-grown, mature apples possess at harvest or thereafter the maximum degree of quality that the genetic makeup of the variety makes possible.

During maturation, an apple becomes sweeter because of an increase in sugar content, particularly sucrose, and its apparent sweetness is further increased by a decrease in the percent of acid. The content of aromatic compounds increases greatly, especially during the last 7 to 10 days of maturation, when the characteristic aroma of each variety first becomes readily detectable.

Because sucrose content changes more during maturation than any other quality constituent measured, it would be the most reliable index of degree of quality at different maturity stages. Sucrose determinations, however, are too time-consuming and expensive for practical use.

Color standards developed

Skin color offers a more practical indication of quality than does sucrose content. Spectrophotometric measurements of skin color have been compared with laboratory determinations of quality constituents. A close correlation has been found between quality increases during maturation and the changes from green to yellow in the background color of the skin.

Consequently, three standard-color cards have been developed for Golden Delicious apples, showing the greenest colors allowed in the three grades, Ill.-U.S. Extra Fancy, Ill.-U.S. Fancy, and Ill.-U.S. No. 1. The Extra Fancy card has the yellow color of a mature Golden Delicious apple, the Fancy card is less yellow, and the No. 1 card, least yellow.

The Illinois Department of Agriculture has legally adopted these standards for voluntary use. A grower who packs Golden Delicious apples to meet the standard requirements under the supervision of a Federal-State inspector can stamp on the package, "Meets Illinois Maturity Standards." General use of these standards would eliminate low-quality Goldens from the market and provide relatively uniform quality within packages.

The standards can also be used with other yellow-skinned varieties. Data have been obtained for developing similar color-quality standards for red apples.

R. V. Lott is Professor of Pomology, Department of Horticulture.

Variation in present packing

The wide variation in quality that may be found in apples not packed according to maturity standards was shown in a study of 20 commercially packed boxes of Golden Delicious apples obtained from Illinois, Maine, and Washington in December, 1960. The Illinois boxes were labeled No. 1, and the others Extra Fancy.

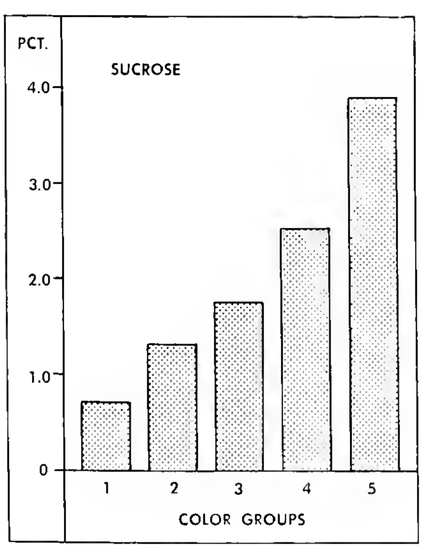
Since many of the apples were greener than the No. 1 standard card, two greener cards were used along with the three standard cards for comparison with apple skin colors. The apples could thus be divided into five color groups.

Quality constituents were determined in each color group from each source. As shown in the chart, the percentage of sucrose was 5.49 times as great in group 5 (Extra Fancy standard) as in group 1 (the greenest apples). Group 5 had a quality rating of very good; group 1, very poor.

With such wide extremes in boxes labeled Extra Fancy, it is obvious that a grade designation is of little use to consumers in selecting apples.

Guides for selecting apples

What criteria can you use in buying apples not packed according to maturity standards?



Percent of sucrose in Golden Delicious apples divided into five color groups. (Group 1, greenest; 5, yellowest.)

First of all, choose a good variety that suits your personal preference for sweetness or tartness. As shown in the table, the early-maturing varieties are low in sugars and high in acid, giving at best only acceptable quality even when mature. At the immature stage at which they are commonly picked, the acid content is about 25 percent higher, the sugar content correspondingly lower, and the quality poor.

Jonathan and the varieties maturing after it all have a sugar content high enough to provide a pleasing flavor if they are picked at or close to maturity. A variety such as Delicious is relatively sweet because of low acidity; Jonathan is equal to Delicious in sugar content but is more sprightly because it has nearly three times as much acid. Golden Delicious varies more in acidity than any of the other varieties; its highest quality occurs in fruits that are high in both sugars and acid.

Yellow Transparent, Duchess, Wealthy, and Willow twig are the only varieties listed which are used primarily for cooking, but some of the other varieties, notably Jonathan, Grimes, Golden Delicious, and Stayman, are much superior to them for all culinary purposes. Delicious is not usually considered a cooking apple but some people use it to their satisfaction.

Usual Range in Sugar and Acid Content of Mature Fruits of Commercially Important Apple Varieties, Listed in Approximate Order of Maturity

Variety	Sugars, pct.	Acids, pct.
Yellow Transparent	7.00– 8.50	.85–1.00
Duchess	7.50– 9.00	.85–1.00
Wealthy	9.75–11.00	.65– .75
Jonathan[a]	11.75–13.50	.60– .70
Cortland	11.00–12.75	.50– .60
McIntosh	11.25–12.75	.45– .60
Grimes Golden	11.50–13.25	.40– .50
Delicious-type[b]	11.75–13.50	.20– .25
Golden Delicious	11.75–15.00	.30– .60
Rome-type[c]	11.00–12.50	.35– .45
Stayman	11.50–13.25	.50– .60
Turley	11.25–12.50	.50– .60
Winesap	12.00–14.00	.50– .60
Willowtwig	11.75–13.00	.75– .85

[a] And its red sports.
[b] Delicious and its early-red-coloring sports such as Starking and Richared, and the recent sports of Starking and Richared.
[c] Rome Beauty and its red sports, such as Red Rome and Gallia.

Whatever variety you buy, choose apples with a bright, attractive color; avoid that "tired" look. The skin of yellow varieties and the background color of red varieties should be predominately yellow; green apples have been picked when still immature and are low in quality. Avoid bruised apples, as bruises greatly increase the amount of waste. If the apples are at room temperature, one of the best indicators of quality is a pronounced varietal aroma. No aroma can be detected in apples that have just been brought in from cold storage.

Storage of apples

An apple is still a living organism after it is harvested. Therefore it should be stored in an environment that will reduce to a minimum the inevitable physiological changes that occur during its ripening. These changes are:

1. A continual decrease in sucrose content, slight in Jonathan to moderately high in Golden Delicious.

2. A continual loss of acidity— as much as 50 percent in Golden Delicious after 120 days in cold storage, and less in other fall-maturing varieties. After January 1 the flavor of cooked apples can usually be enhanced by adding lemon juice, citric acid, or ascorbic acid.

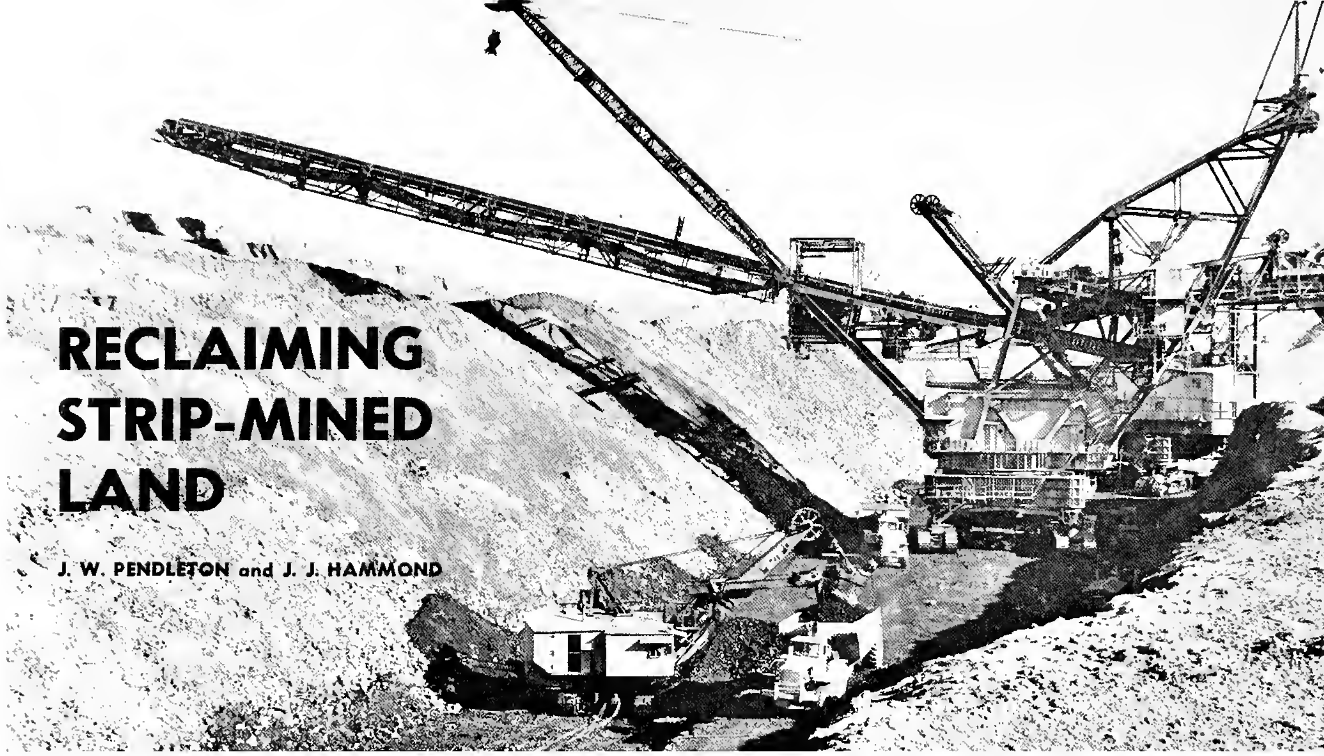
3. The gradual loss of aromatic compounds.

4. Decreased firmness, causing unsirable mealiness in some varieties.

5. Loss of moisture by transpiration. If the loss is more than 5 percent, shriveling usually results.

All these changes are accelerated by increasing temperature, and the rate of water loss is increased as percent of relative humidity decreases.

Ideally, apples should be stored at 30° F. and 100 percent relative humidity. Although such conditions cannot usually be supplied, especially in the home, they should be approximated as closely as possible.



RECLAIMING STRIP-MINED LAND

J. W. PENDLETON and J. J. HAMMOND

STRIP MINING accounts for slightly more than half of Illinois's annual coal production. Approximately 4,700 acres are being stripped each year. The annual value of the strip-mined coal is about $104 million.

About 62 percent of the land stripped in Illinois is owned by coal companies, and 28 percent by private individuals; the remainder is leased or belongs to recreational organizations, miscellaneous companies, or the State of Illinois.

Previous research

The Illinois Agricultural Experiment Station has for many years been interested in the agricultural potential of spoil banks after stripping. Two publications reporting such research have been issued by the Experiment Station: Bulletin 547, "Reclaiming Illinois Strip Coal Lands by Forest Plantings," and Bulletin 628, "Reclaiming Illinois Strip Coal Lands With Legumes and Grasses."

These publications contain detailed descriptions of soil texture and chemical analyses of the spoils found in different areas of the state. They also contain recommendations for forest and crop species best adapted to spoil banks.

Some strip mine spoils are naturally infertile and acid to the point that vegetation is very difficult to establish. Other areas can be used immediately for trees or forage crops.

Present research

The Department of Agronomy is at present conducting research in Fulton County. Before stripping, this particular land was generally productive agriculturally. The overburden carries a relatively high proportion of loess and glacial till over calcareous shale.

The resulting spoils are not acid, and they have high mineral fertility. Over 90 percent of the area shows a pH slightly above 7.0, phosphorus (P_2) tests above 140, and potassium tests above 150. Forage species are not difficult to establish on these spoils, and several cattle enterprises exist in the area.

Our research plots are located on a newly graded (almost level) 90-acre spoil site. Fertility and the adaptability of various crop species and rotations are being studied.

One question we're trying to answer is why certain crop species do extremely well on new spoils in this area and other do very poorly. Corn, for example, is a poor performer on first-year spoils, while alfalfa thrives as well as on unstripped land, or even better.

ABOVE PICTURE: Large machines in background remove the soil and rock (overburden) above the seam of coal. The small shovel in front loads the coal into huge tractor-haulers, which carry it to crushers and washers.

Strangely, after a few years of alfalfa, corn yields very well. This is not due to nitrogen fixed by the alfalfa but seems to be more likely due to an increase in biological activity and improvement in soil physical conditions.

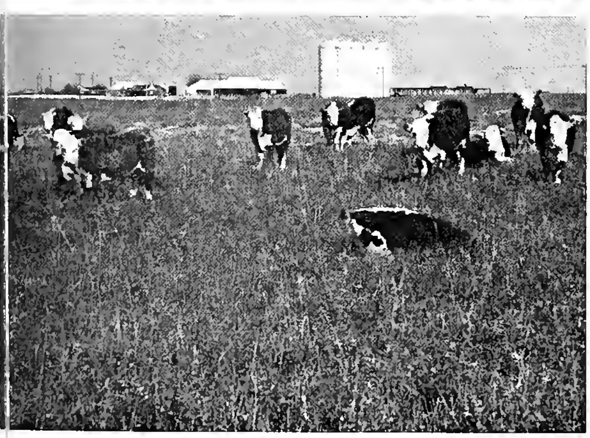
In one experiment tremendous amounts of Leonardite, an organic material, are being incorporated into the soil. Possible minor-element deficiency or toxicity is also being investigated. As an example of "way out" research, a certain mycorrhiza fungus is being directly added under hills of corn.

This year irrigation is being tried on corn along with heavy fertilizer rates. The very nature of strip mining necessitates that lakes be left occasionally. These provide a convenient source of irrigation water.

The objective of all these studies is to determine what environmental factors are preventing a rapid return to an agriculture as profitable and as diverse as before stripping.

ılldozer grades off the top of a spoil ridge. In certain able soils the stripped areas can be returned to complete ultural utilization.

This leveled strip-mine area in Fulton County produced 100-bushel corn six years after coal was removed. Excellent alfalfa had been grown the preceding four years.



e crops do well on mine spoils in Fulton and Knox ıties, supporting a number of successful cattle enterprises. e top picture, haylage is being made from a legume-grass re only two years away from stripping.

Pendleton is Associate Professor of Agronomy, and J. J. Ham- is Research Assistant. Early research was in cooperation with the Coal Strippers' Association. Current research is receiving finan- pport from the Truax-Traer Coal Company.

Several species of conifers and hardwoods do well on strip-mine spoils. This pine plantation is in Saline County.

Many spoils areas around the state have been developed for swimming, boating, fishing, and other recreation. These areas also provide shelter for birds and small animals.

GOOD CHEESE is produced with a pepsin preparation

S. L. TUCKEY and N. P. MELACHOURIS

High price of rennet extract, the milk-clotting preparation generally used in cheese making, speeds the search for a cheaper substitute

We don't know for sure the origin of cheese-making, but cheese may have been discovered when man first learned to make a bag from the stomach pouch of a domesticated animal such as a cow or a goat. He learned that he could carry liquids like water in this bag without change, but that when milk was transported in it, curds and whey separated from the milk.

Many years elapsed before man learned the exact cause of this phenomenon; that is, that a clotting agent or enzyme in the inner wall of the stomach was with time transferred to the milk, eventually causing the milk to form curds and whey. The enzyme responsible for the change is known today as rennin, but its source is still the lining of the abomasum or fourth stomach of a calf being fed milk.

Mechanisms of clotting

Only within the last decade have protein and colloidal chemists been able to determine, with a fair degree of confidence, the mechanisms involved in the clotting process and the formation of a firm gel or coagulum when rennet is added to milk.

Although milk contains a number of different proteins, casein is the only one involved in the clotting phenomena. Casein is a very complex protein made up of a number of units, each having distinct properties. These units or entities are known as alpha, beta, gamma, and kappa casein. Kappa casein is associated with alpha casein and is believed to be the stabilizing protein which keeps alpha casein in dispersion. Beta and gamma caseins may also have comparable stabilizing units associated with them. At the moment, however, kappa casein is the only one which has been isolated.

Casein exists in milk in the form of spherical particles. It is believed that the first stage of rennet action is its action on alpha casein with the release of kappa casein and the unfolding of the spherical particle into protein strands. Clotting of milk occurs when sufficient unfolding occurs and a network of the protein strands forms a gel. Clotting occurs rapidly when the temperature of the milk is between 86° F. and 104° F., but decreases as the temperature is lowered. No clot forms at 40° F. and below.

Several clotting enzymes

Many other milk-clotting enzymes besides rennin are now known. They have been isolated from a number of animal sources, they are known to be formed by a number of different microorganisms, and they have been found in several plants.

According to H. A. Veringa there are, in tropical areas particularly, many plants from which milk-clotting enzymes can be isolated. As early as 1906, Chodat and Rouge reported that for centuries the Majork Islanders had been using fig twigs and leaves for cheese-making. In 1907 Gerber succeeded in making an enzyme preparation from the latex of *Ficus carica*. Later enzymes were also prepared from other species of the genus *Ficus*.

With one exception, these enzyme preparations have not been particularly successful in replacing rennet extract for making cheese. The reason is that the proteolytic properties of the substitutes differ too widely from those of rennet extract. To be suitable for cheese-making, an enzyme must possess more than the property to clot milk. It must have proteolytic properties which permit hydrolysis of casein without production of objectionable flavors, and at the same time produce a cheese with a smooth texture.

The milk-clotting enzyme that shows the greatest promise as a substitute for rennet extract is pepsin, which is obtained from a hog's stomach and which has properties similar to those of rennin. Conflicting results have been reported ever since 1900, however, by investigators who have studied the suitability of pepsin for making cheese. While some workers have reported favorable results, others have found that pepsin causes a bitter flavor to develop in the cheese during ripening, making the cheese unpalatable.

Why pepsin was re-studied

The need for re-studying the possibilities of pepsin as a substitute for rennet extract in cheese manufacture became apparent about 1959, when the price of rennet extract began rising sharply. It more than tripled within a year, shooting from \$5.25 a gallon in 1959 to \$19.75 in 1960.

Continued high prices are expected, as the longtime outlook for rennet extract is one of scarcity. Dairy cow population has decreased both in the United States and in Europe, thus limiting the supply of calf vels for the production of rennet extract. Furthermore, cattle slaughtering is more decentralized today than it was 20 years ago.

A definitive study was therefore undertaken to determine whether pepsin preparations, as produced today, could be satisfactorily used as a substitute for rennet extract in making Cheddar cheese.

S. L. Tuckey is Professor of Dairy Technology, Department of Food Science; and N. P. Melachouris is Research Assistant in Food Science.

Changes measured

Biochemical reactions during cheese ripening are responsible for the changes in body and texture and the formation of compounds that give cheese its unique flavor characteristics. These reactions include degradation of protein, hydrolysis of milk fat, and the fermentation of lactose, and are initiated by enzymes present in the original milk, in the clotting preparation, and in the cells of microorganisms in the cheese.

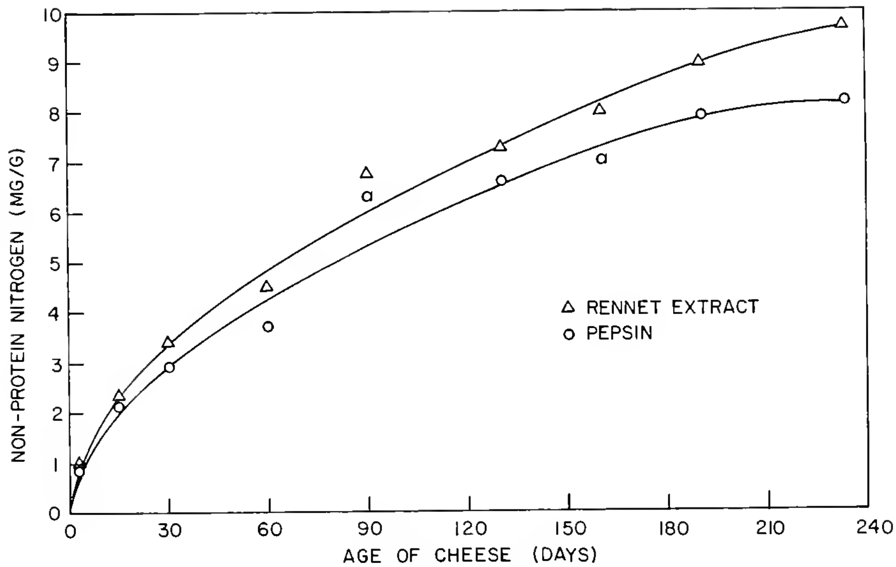
The main chemical change which occurs in the cheese protein during ripening is its gradual degradation. This process is accompanied by the formation of nonprotein nitrogenous compounds such as peptides, amino acids, and ammonia. Hence one way to measure cheese ripening is to determine the increase in nonprotein nitrogenous compounds. A more precise method is to determine the quantity and order of appearance of specific amino acids as they are split off from the polypeptide chain by the proteolytic enzymes.

The physical changes that occur during ripening are just as important as the chemical changes. If undesirable body, texture, and flavor characteristics develop, causing the cheese to be unpalatable or unsalable, then measuring chemical changes loses its significance.

In this investigation a series of experimental lots of cheese were made with the clotting preparation as the only variable. That is, various amounts of rennet extract and a pepsin preparation were used in the different lots. The increase in total nonprotein nitrogenous compounds was measured, as well as the specific amino acids liberated. Physical changes in the cheese were judged by taste and feel.

Differences noted

The data obtained from the analyses show that the lots of cheese made with rennet extract ripened faster than did the cheese made with pepsin. The graph illustrates the change in nonprotein nitrogen throughout the ripening period. At each period of testing, the increase



Protein degradation, as measured by production of non-protein nitrogen, during the ripening of Cheddar cheese made with rennet extract and with pepsin.

Amino Acids Liberated During Ripening of Cheddar Cheese Made With Rennet and With Pepsin

Amino acids	Rennet treatment				Pepsin treatment			
	Age of cheese (days)				Age of cheese (days)			
	2	60	130	235	2	60	130	235
	micromoles of acid per gram of cheese							
Alanine	—[a]	2.24	10.77	12.34	—	2.02	8.97	11.56
Arginine	0.28	2.46	3.55	5.79	0.57	1.95	4.87	4.76
Aspartic acid	—	1.42	2.93	4.50	—	1.27	1.65	5.78
Glutamic acid	1.22	8.84	10.61	28.09	1.70	5.64	11.42	34.76
Glycine	—	2.93	5.86	7.86	—	2.00	3.73	4.93
Histidine		1.28	1.57	4.58	—	1.62	2.00	5.91
Isoleucine	—	—	1.52	4.11	—	0.45	0.99	6.48
Leucine	+[b]	4.50	7.85	54.15	2.44	4.57	9.22	40.42
Lysine	0.61	2.12	5.33	8.61	2.87	2.94	6.36	9.57
Methionine	—	1.60	3.15	7.03	0.46	1.47	3.15	9.51
Phenylalanine	—	1.15	0.72	10.95	—	0.90	0.96	9.44
Serime	—	0.57	1.04	2.66	—	0.85	1.71	4.18
Threonine	—	2.68	3.86	3.94	—	3.77	3.02	4.61
Tyrosine	0.11	0.88	0.77	1.93	0.33	0.44	0.82	1.71
Valine	—	1.70	12.72	40.42	0.85	3.41	7.08	33.13
Total	2.22	34.37	72.25	196.96	9.22	33.30	65.95	186.75

[a] A minus sign (—) = absent. [b] Trace amount present.

of nonprotein nitrogen compounds was significantly greater in the cheese made with rennet extract. Although the same amino acids were liberated in each lot of cheese, the cheese made with rennet extract had a greater concentration of amino acids after 60 days of ripening (see table).

Taste tests of the cheeses confirmed the conclusions drawn from the chemical tests. However, although the cheese made with pepsin was slower to ripen than that made with rennet extract, the end products did not differ significantly in flavor. In other words, pepsin does not cause a specific flavor defect when this enzyme preparation is properly used for making Cheddar cheese.

It is anticipated that greater amounts of pepsin will be used in cheese manufacture in the near future, because it is an economical and satisfactory substitute for rennet extract when the latter is priced out of the market.

GREENHOUSE TOMATO PRODUCTION:

Feasibility in southern Illinois

J. W. COURTER

LARGE YIELDS of high-quality tomatoes can be produced in greenhouses during the winter and spring months when supplies of fresh tomatoes are lowest and prices are relatively high. Successful greenhouse production, however, requires a substantial investment for greenhouse facilities, skillful management, and technical know-how.

With the development and improvement of plastic greenhouses, less capital is needed than in the past. When low-cost labor and native lumber are available, the necessary investment is decreased still further. The initial expense for a plastic greenhouse may be one-fourth, or less, of the cost for a glass greenhouse. Considerable maintenance is required, however, to keep a plastic greenhouse in good repair.

Temporary plastic greenhouses have been used for growing tomatoes at the Dixon Springs Experiment Station since 1961. Results of preliminary experiments, reported here, indicate that growing tomatoes in greenhouses can increase farm income and provide additional jobs in southern Illinois.

Fall and spring crops

During the last two years good yields of tomatoes have been harvested from fall and spring crops grown in polyethylene-covered greenhouses (Fig. 1). Fall crops (harvested during November and December) produced an average yield of 8 to 10 pounds of marketable tomatoes per plant for standard varieties. Spring crops (harvested April through June) averaged 12 to 16 pounds per plant.

Yields of 10 pounds per plant are approximately equivalent to 100,000 pounds of tomatoes per acre. Wholesale prices for greenhouse tomatoes in Chicago have averaged 28 to 32 cents per pound during these harvest periods for the last two years.

Late spring tomatoes

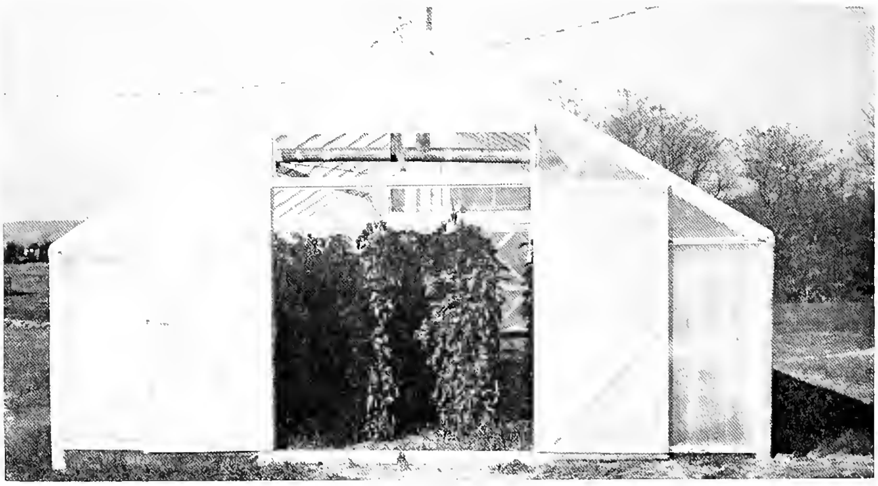
A late-spring cropping system seems well-suited for temporary polyethylene-covered greenhouses (Fig. 2). Last year plants were set in one greenhouse on March 1 rather than in January, the time for a conventional spring crop. The later planting date, bypassing most of the severe winter weather, permitted the plants to be grown under more favorable conditions of longer and warmer spring days.

About 900 pounds of marketable tomatoes were produced, for an average of 12 pounds per plant. The

Greenhouse tomato plants, trained to a single stem, grow 10 feet tall or more. A good crop is set on this plant. (Fig. 1)

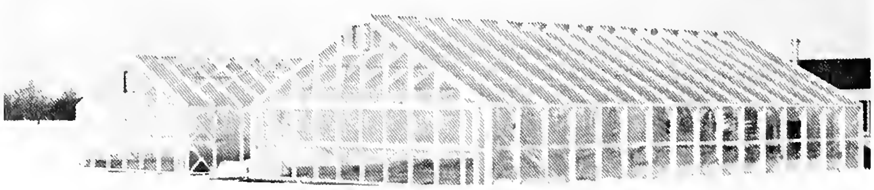
crop was harvested from mid-May through June. Thus the first of the crop could be marketed 4 to 6 weeks before early fresh-market staked tomatoes, which are harvested between June 25 and July 25 in southern Illinois.

The greenhouse was heated with an LP gas convection furnace. Ventilation was controlled manually by opening vents. Total costs for materials (lumber and polyethylene) and heater were about $250 (45 to 50 cents a square foot). Fuel costs



This 17-by-30-foot polyethylene-covered greenhouse was constructed with cedar posts and 2 x 4 lumber at a cost of about $150. (Fig. 2)

Two new rigid frame greenhouses permit continuation and expansion of the research. The one on the left is 20 feet wide; the other, 30 feet wide. Both are covered with 5 mil polyester plastic film. (Fig. 3)



averaged 2.5 cents per pound of tomatoes produced.

New greenhouse structures

Two semipermanent greenhouses were built in 1963 (Fig. 3), permitting continuation and expansion of the research. They were made possible by financial support from the Area Redevelopment Administration.

The new greenhouses are modified Illinois lumber rigid frames (ILLINOIS RESEARCH, Winter, 1960), covered with Mylar, a long-lasting polyester plastic film. Thermostatically controlled exhaust fans provide forced ventilation, and warm-air furnaces provide heat.

Materials (framing lumber, glue, nails, concrete foundation, and 4-year Mylar) cost about $1500 for a 30- by 96-foot structure. This amounts to 50 cents a square foot, excluding labor. Fan ventilation and heat would add $750 to $1500 (25 to 50 cents a square foot).

Current and future studies

Specific topics now under study include integration of greenhouse production into farm operations, crop rotations, production schedules, capital requirements, costs, and marketing. Experiments will be conducted to learn whether tomatoes can be profitably grown for marketing during January, February, and March, when high-quality tomatoes are in very short supply.

Special tomato varieties for the greenhouse environment

GREENHOUSE tomato production calls for special varieties that will yield well under the environmental conditions of greenhouse culture. During the last two years, 30 greenhouse tomato varieties and advanced breeding lines have been tested in plastic greenhouses at the Dixon Springs Experiment Station.

A two-crop schedule, similar to that used by commercial growers, was followed. Fall tomato crops were seeded in mid-July, the plants were set in the greenhouse in early September, and the crops were harvested during November and December. Spring crops were seeded in mid-November, the plants set in early January, and the crops harvested from April through June.

An electric vibrator aids pollination.

The plants were grown at spacings of about 4.5 square feet per plant, or the equivalent of 9,680 plants per acre. Temperatures at 58° to 60° F. were maintained during the night and 70° to 80° F. during the day (65° to 70° F. on cloudy days). The flowers were pollinated 3 to 5 times weekly with the aid of a mechanical vibrator. Varieties were grown in single-row plots because of space limitations.

Varieties recommended for greenhouse forcing are Ohio WR-7 (pink), Michigan-Ohio Hybrid (red), and Tuckcross 0 (red). Tuckcross 0 tends to produce more small tomatoes (3 to 5 ounces) but it is resistant to leaf mold, a disease which can be serious in plastic greenhouses. The pink-fruited, leaf-mold resistant experimental varieties Ohio 0, Ohio 1, R-25, and P-115 looked promising in these tests (see table).

Yields from the fall crops were lower than from the spring crops because of the short fall and winter days and a shorter harvest period.

J. W. Courter is Assistant Professor of Horticulture, Dixon Springs Experiment Station.

Yields of Selected Tomato Varieties in Greenhouse Production Tests

Variety	Fruit color	Leaf mold[a]	Marketable yield, lb. per plant 1962	1963	Av. fruit size, oz.	Av. yield, tons per acre
FALL CROP						
Michigan-Ohio Hybrid	Red	S	8.3	10.7	6.2	46.0
Tuckcross-0	Red	R	8.8	9.9	5.9	45.5
Ohio WR-7	Pink	S	8.0	10.3	6.5	44.5
R-25	Pink	R		8.2	6.7	40.0
Ohio 1	Pink	R	7.9		6.0	38.2
Ohio 0	Pink	R	7.9		5.9	38.2
Hoosier Hybrid	Pink	S		7.6	6.9	36.8
Spartan Pink-10	Pink	S	5.8	8.5	6.3	34.9
P-115	Pink	R	6.7	6.7	5.4	32.4
SPRING CROP						
P-115	Pink	R		18.8	6.4	91.0
Tuckcross-0	Red	R	16.1	16.0	5.6	77.9
Michigan Ohio Hybrid	Red	S	13.8	16.9	5.7	74.5
Spartan Pink 10	Pink	S	12.5		7.1	60.5
Ohio WR-7	Pink	S	10.4	12.8	6.5	56.1
Cherry	Red	S		10.2	1.2	49.4
Waltham Improved	Red	R	7.4		4.0	35.8

[a] S — variety is susceptible to common strain of *Cladosporium fulvum*, R — variety is resistant.

School Bells Ring Again for Farmers and Their Wives

University staff members discuss poultry management and disease problems with participants in poultry workshops at Dixon.

W. D. MURPHY

A YOUNG Illinois farmer who had gone broke in the early 1950s, started farming again in 1960. The following year he and his wife enrolled in a farm and family business management workshop conducted in their county by the Cooperative Extension Service. This workshop, he now says, has increased his net farm income by more than $2,000 a year.

Last winter, farm people in more than 90 Illinois counties enrolled in short courses and workshops offered by the Extension Service. Farm and family business management workshops were held for the third year. In addition, poultry production and marketing workshops were held for the second year, and these courses were offered for the first time: forage production and utilization, beef farming, swine farming, and vegetable production.

The short courses and workshops provided technical, college-level training for specialized commercial farmers. County farm and home advisers, area advisers, and specialists from nearly every department of the college were involved.

Each course offered 8 to 12 hours of instruction. Most required the payment of a small enrolment fee to cover the cost of a handbook and special materials.

The poultry schools at Dixon and Kankakee served groups of counties to reach scattered egg producers. Several groups of counties combined to make the swine and beef schools available to producers when a single county could not provide a large enough enrolment to justify a school. Even so, the college specialist staff was not able to conduct all the beef and swine schools that were requested. Every effort will be made next winter to offer courses in the counties or groups of counties that were omitted from last winter's schedule.

W. D. Murphy is Assistant Director of the Cooperative Extension Service.

Forage production and utilization

Nearly 500 farmers enrolled in forage production and utilization workshops in 14 counties. At least 2 hours of teaching and discussion were offered for each of the following units: Producing high-quality forage and lots of it. Forage crop insects and diseases. What is new in feeding beef cattle? What is new in feeding dairy cattle? Do forage crops pay? Muscles or machines?

Poultry production and marketing

Poultry production and marketing workshops at Dixon and Kankakee attracted 130 poultry producers from 22 counties. Six 2-hour evening sessions covered the following areas: the egg business in Illinois, fly and parasite control, avian physiology, lighting programs for egg production, poultry housing and ventilation, prevention and control of diseases, cost accounting in the egg business, and poultry and egg marketing.

Beef schools

Eighteen beef schools, conducted for about 1,000 producers in 21 counties, covered beef feeding and management, buildings, equipment, feed handling, disease control, and economics of various systems of beef production. These schools were taught by specialists in animal science, agricultural engineering, and agricultural economics.

Swine schools

Swine schools proved especially popular. Thirty-two schools were held for 1,900 producers in 37 counties. Intensive instruction was offered in feeding, breeding, management, buildings and equipment, feed handling systems, disease control, and economics of various systems.

Farm and family business

Farm and family business management schools were designed to help young couples make wise decisions for the farm and home. Each school consisted of 12 to 16 hours of instruction, covering farm budgeting techniques, choosing alternatives of production, family economics and fiscal management, and the use of credit. Last winter the schools were conducted in 78 counties with an enrolment of 1,100 couples.

Vegetable production

Two schools were conducted for commercial vegetable growers in Cook County. One dealt with the principles of plant nutrition, soil fertility, and soil management. The other covered vegetable diseases and their control.

Participants' reactions

Farmers attending the workshops liked the timely and practical subject matter. They seemed to particularly appreciate the chance to solve problems found on their own farms and to discuss subject matter in more detail than in ordinary meetings.

"Best Extension program ever," said one man after attending a poultry workshop. Said another, "Let's have more sessions like these."

Foreign Aid Means Learning as Well as Teaching

K. E. GARDNER

PROVIDING agricultural assistance to developing countries is a highly complex effort. Before proceeding on a foreign assignment, an agricultural specialist needs not only health inoculations but a series of technical, cultural, socio-economic, geographic, historic, and political injections pertaining to the country and the general region where he is going.

What we need to understand

Too often we assume that we can transmit directly to the developing nations most of the information we have gained from agricultural research in the United States. In truth, in the early stages, we go to these countries to learn, not just to teach.

Most of the United States effort to help developing countries is centered in lands which could be categorized by the rather harsh term "primitive." Some of the rural people of these countries have neither a beast of burden nor even the wheel. Tools are definitely primitive and farming methods may be pre-bronze age. Not only is the agriculture primitive, but so are education, transportation, industrialization, and even local government.

We are not even certain that we comprehend what motivates the peoples of developing lands. What does an illiterate man want — newspapers, magazines, books? A transistor radio might be a lot more appropriate. It may be that he wants a water-proof roof on his hut more than anything else. There is no question but that he wants more food. Is his principal desire to move to a town or city and get away from village life? If so, what is he prepared to do when he gets to town?

We must understand the fears and worries, the customs, the religious needs, the nutritional problems, the land-tenure practices, and a host of other highly complex aspects of the life of the country.

American colleges of agriculture know extremely little about the crops, the soils, the climatic conditions, and the work habits of people in tropical countries. True enough, certain researchers in Hawaii are experts on the pineapple and a few other tropical crops, and our citrus experts in Florida, Texas, and California are leaders. But such fruits are relatively unimportant in a world which needs protein first and calories second.

One thing in which American agriculture leads the rest of the world is the production of food and fibre per farm worker. In few, if any, of the developing countries, however, is production per man very important. What the world needs to know most is how to produce a lot of food and fibre per acre. American agriculture has not won many blue ribbons in this field! It comes as a tremendous shock to most Americans to learn that at least a dozen countries produce more wheat per acre than we do. And even Spain surpasses us in rice production per acre.

What we can provide

An understanding of our shortcomings should not blind us to the valuable contributions which United States agriculture and capabilities can provide for developing nations.

1. First, we can show a sympathetic interest in the problems of the country that we are assisting. We can show concern not merely for the large landowner and the few progressive farmers, but also for the last man in the smallest village.

2. We have developed techniques for extending the benefits of agricultural research to the people rather than merely "journalizing" these results. Some extension methods used 50 years ago may be profitably resurrected and applied alongside the latest appropriate tools of the trade.

3. We shall take with us to the developing countries a considerable understanding of the "scientific method" and all that this implies. The American attitude that no problem is insurmountable may get a few "lumps," but it is nevertheless an asset.

4. We can, by our example, help the people of a developing country to appreciate the importance of sincere hard work. In the United States, as in few other places, there is a high respect for not only mental but physical effort. Many problems in the developing countries will yield only to a good deal of sweat.

5. We approach the problems with very little prejudice concerning these countries or their peoples, and we have few preconceived ideas to drag down our hopes for achievement.

6. We can make it crystal-clear to the people that we are there entirely to assist them, not to do the job for them. We can add prestige to their work by pointing out that they can learn to do the job themselves and that we have no intention of staying on in positions of advisorship, leadership, or administration.

7. We can describe and propose a sound basis for selecting and rewarding talented workers on the basis of merit rather than influence.

8. We shall take with us the valuable concept of the word "inclusive" rather than "exclusive" as applied to all types of education.

Conclusion

A healthy appreciation of our shortcomings as well as our strengths will be valuable as we organize agricultural assistance programs. Our American practical ingenuity plus our positive and optimistic approach will aid us immeasurably.

K. E. Gardner, Associate Dean of the College of Agriculture, recently helped to establish a Land Grant type of college at Njala, Sierra Leone.

RESEARCH IN BRIEF

Characteristics of an Organism Causing a Type of Anemia in Cats Are Studied

Of all the domestic animals, cats are affected most frequently by various forms of anemia. Recognition, diagnosis, and treatment of these anemias constitute the most significant challenge in small animal medicine.

The disease caused by infection with *Hemobartonella felis* may assume an acute, subacute, or chronic form, each characterized by an elevated temperature, lethargy, loss of weight, and a severe anemia.

Research on feline hemobartonellosis is currently being conducted in the College of Veterinary Medicine. Objectives are to develop specific diagnostic procedures, to study the origin and development of the disease; and to determine the biophysical characteristics of the parasite.

Both naturally and experimentally infected cats are being studied. The fluorescent antibody and acridine orange staining techniques have both been successfully used to demonstrate the presence of the agent in erythrocytes (red blood cells) fixed by formalin and alcohol. These techniques have been more accurate for detection of the parasite than the conventional Wright's or Giemsa's staining procedures.

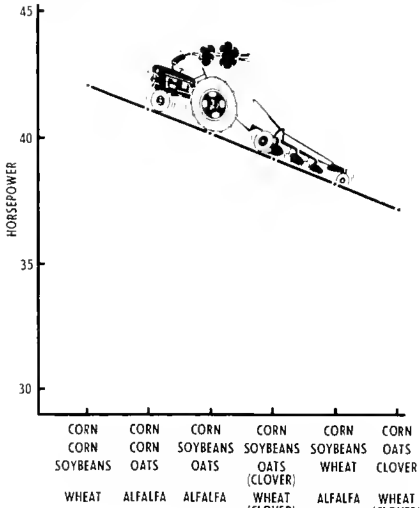
Results of the blood examinations have supported previous findings that the anemia is of a macrocytic type, the red blood cells being larger than normal ones. A study of the ultrastructure of the *Hemobartonella* has been made by electron microscopic examination of infected erythrocytes prepared by shadow casting and ultra-sectioning techniques. An indisputable classification of *H. felis* remains to be established, but it is possible at this time to make some general statements. None of the organelles characteristic of a cell were contained by the *Hemobartonella*, thus excluding it from the protozoan classification. It is not likely to be of a viral nature, as evidenced by its size and content of both deoxyribonucleic and ribonucleic acids. The most likely classification is in the order rickettsiales. — *Erwin Small and M. Ristic*

The Less You Till Your Soil, The Easier It Will Plow

A vacuum gauge was attached to a tractor manifold so that it would measure the horsepower required to plow cornstalk plots that had been in six different rotations for 28 years at Urbana.

The plowing tests were made on October 31, when soil moisture conditions were excellent for plowing. The soil type was Drummer silty clay loam.

Where cultivated crops had been grown three years out of four (corn, corn, soybeans, wheat), 42 horsepower was required to pull a two-bottom (16-inch) "turnover" plow. Only 37 horsepower was needed where a cultivated row crop was grown one year in four. — *J. W. Pendleton and C. H. Farnham*



Horsepower requirements on plots where six different rotations had been followed since 1935.

A "Pattern" of Substances Is Found During Growth and Development of a Cell

One problem facing biologists is discovering how the cell develops, grows, and dies under normal conditions. A method of attacking this problem is to test the materials present in the cell at various stages of its development and to measure the relative concentration of each one.

The intestinal epithelium offers a good choice of cells with which to experiment, since the normal intestinal cell has an average life span of 1½ days and is constantly being replaced. Studies of these cells in the College of Veterinary Medicine have demonstrated that a pattern is formed by the relative concentrations of lipids, proteins, acid mucopolysaccarides, and glycogen in the cytoplasm at the different stages of the cells' growth and development.

In general, it may be said that during the development of the cell from the youngest stage to maturity the concentration of lipid and acid mucopolysaccarides declines, while the concentration of protein and glycogen rises. At any one stage of development the concentrations of cytoplasmic materials remains remarkably constant, thus indicating that the variation from animal to animal within the species is negligible.

It is also interesting to note that in similar experiments with cells of an invertebrate animal, the concentrations of these same materials were found to be virtually the same. This would indicate that the observed pattern may be normal for the early stage of all cells, regardless of their origin or their eventual destiny in the structure of the body.

Research is being continued to demonstrate more specific substances such as individual proteins and enzymes necessary for the synthesis of those proteins and glycogen. Ultra-

structural studies of these normal cells are also planned to help characterize the cells by a second means.

The present experiments are giving results that will help to elucidate processes that take place during the normal growth and development of the cell. By using the same procedures on abnormally growing cells and comparing the results, information will be obtained that may give an insight into what is going wrong, chemically and structurally, in cancer-like cells — *Diane K. Normandin*

Child Rearing and Family Life Attitudes in Germany, Sweden, and the United States

In countries with similar governments and technological societies, are attitudes toward child rearing and family life also similar or are they different, particularly among the younger generation?

To get some information on this subject, German, Swedish, and American university and gymnasium students were asked to respond to a questionnaire about their attitudes toward authoritarian control of children and women's position in society.

The Americans expressed the least authoritarian attitudes toward child rearing. That is, they seemed to approve of more flexible and permissive child-rearing practices, while the Germans and Swedes desired stricter parental control. The Germans expressed slightly more controlling attitudes than the Swedes. Both approved the use of more frequent and severe punishment than the Americans did.

Attitudes toward role choice for women differed among the three groups. The Germans presented the most restrictive attitude, indicating that they felt a woman's place is in the home. The Swedes expressed the most liberal attitude, giving the Swedish woman the most freedom in choosing her role in society. Americans were not as restrictive in their attitudes as the Germans nor were they as liberal as the Swedes. All three groups believed that an equalitarian, individualistic husband-wife relationship is most desirable. — *G. G. Gobbel*

Several Factors Measured on Beef Carcass to Estimate Yield of Lean, Edible Meat

The value of beef animals or beef carcasses is primarily determined by two factors: (1) the relative amount of lean, edible meat, and (2) the eating qualities of that lean.

It is generally assumed that there is a positive association between fatness of the live animal and potential eating qualities. Furthermore, the dressed carcass as a percent of the live animal is positively associated with fatness. It is therefore important that beef which is to be sold as fresh roasts and steaks be finished before marketing.

Several factors can be measured in the beef carcass to provide an estimate of the lean yield of the carcass. The most commonly used criteria include carcass weight, fat thickness at the twelfth rib, estimated kidney and other internal fats, and rib eye area measured on the cross section between the twelfth and thirteenth ribs. If one describes each of these characteristics, one can express their effects.

Observation of the relationship between these characteristics and lean yield as a percentage of the chilled side weight have been made on about 1,100 cattle in the past two years. All the cuts were boneless except the loin, in which the finger bones and the feather bones remained; and the rib, in which a 6-inch section of the rib itself remained. The total bone remaining in the retail cuts was estimated to be about 1 percent of the side weight.

All cuts were trimmed to a fat thickness of 0.3 inch and all lean trim was made into a ground beef stock with an estimated 80 percent lean and 20 percent fat. On this basis the lean yield averaged 62 percent of the carcass weight, with a practical range in yield from 53.7 percent to 70.3 percent.

A reduction in lean yield of about 1 percent was associated with each of these factors: (1) a 100-pound increase in carcass weight; (2) a 1-percent increase in kidney and other internal fats. A reduction in lean yield of about 0.75 percent was associated with an increase in fat thickness of 0.1 inch. An increase in lean yield of about 0.75 percent was associated with an increase of 1 square inch in rib eye.

The lean yield percentages ranged from about 13.4 percent below the average value to 13.4 percent above the average value. Such a range can easily be found within a given quality grade. Thus within a grade a value difference of more than 26 percent can be found between meaty carcasses and those having a low lean yield. In terms of a $36 per hundredweight carcass market, this difference represents $9.60 a hundredweight.

While these measures do not give a perfect prediction of lean yield to be expected from a carcass, they do provide very meaningful guidelines for maximizing lean yields. The most significant criterion from the standpoint of both reliability as an indicator of lean yield and magnitude of effect, is fatness. Insasmuch as increases in fatness are associated with reduced lean yield, it is important that cattle be correctly finished, with enough finish for satisfactory eating qualities, but without unnecessary reduction of lean meat. — *B. C. Breidenstein*

INDEXES AVAILABLE

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FARM BUSINESS TRENDS

Changes in net farm income from 1962 to 1963 showed quite diverging trends among different systems of farming in Illinois. This observation is based on a study of record-keeping farms in northern Illinois. The farms were divided into four groups — grain, feeder cattle, hog, and dairy. All farms were 180 to 259 acres in size. Farms within each type-of-farming group were similar in quality of soil and managerial inputs.

With excellent crop yields over most of the state in 1963, grain farms had a net income of $10,516, as compared with $9,860 in 1962. This increase continued an upward trend that began in 1959.

Feeder-cattle and hog farms, on the other hand, had lower net farm incomes in 1963 than in 1962. Cattle farms experienced an especially sharp drop, as the result of higher prices for replacement cattle in the fall of 1962 and sharply lower slaughter-cattle prices in 1963. Net income in 1962 was $11,811; in 1963, $4,629. The same farms had experienced a sharp rise in net income from 1961 to 1962.

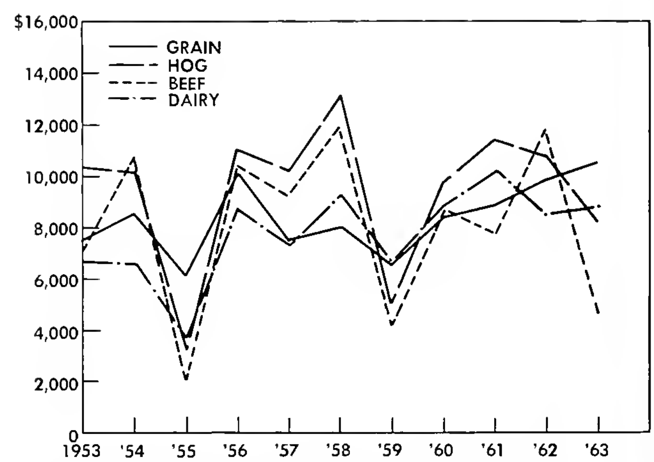
With lower prices for hogs in 1963, net income on hog farms dropped from $10,768 in 1962 to $8,225 in 1963.

Net income on dairy farms has changed less from year to year than that on either hog or beef farms. With the excellent 1963 crops, net income on dairy farms was $8,897, as compared with $8,577 in 1962.

Variations in net farm income since 1953 are shown in the chart at right. The net-income measure used is "farm and family earnings." It is calculated by subtracting cash operating expenses, purchased feed and livestock, and all depreciation from the sum of cash farm sales, change in value of farm inventories, and value of farm products consumed. Farm and family earnings represent the returns to the farm family for all unpaid labor, interest on invested capital, and management inputs used in farming. For rented farms, the farm and family earnings shown in the chart would be divided between tenant and landlord.

Crop production is the basic source of income on most Illinois farms. For this reason, variations in net income for all systems of farming are influenced by variations in weather and the resulting crop yields. Net income on cattle and hog farms, which market a large share of their crop production through livestock, is further affected by market prices for livestock. The cyclical pattern of income changes shown in the chart for cattle and hog farms has resulted largely from the combined effect of changes in crop yields and livestock prices. Net incomes have not varied as widely on grain farms as on livestock farms. Although crop yields have an important effect on grain-farm incomes, the yearly average prices for corn and soybeans have not fluctuated like cattle and hog prices.

Farm operating costs have consistently moved up during the period covered by the chart. However, the yearly changes in net farm income largely result from changes in gross income, which in turn are influenced by changes in total production and market prices for farm products. — *Allan G. Mueller, Associate Professor of Farm Management*



Farm and family earnings, 1953-1963, on selected 180- to 259-acre farms in northern Illinois.

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Fall, 1964

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Movement being a horse's specialty, good bone structure is essential. This fact has prompted a study of normal and abnormal bone development in young Thoroughbreds (page 12).

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard . . . . Dean and Director

M. B. Russell . . . . Associate Director

Adrian Janes . . . . Station Editor

Margery E. Suhre . . . . Editor, Illinois Research

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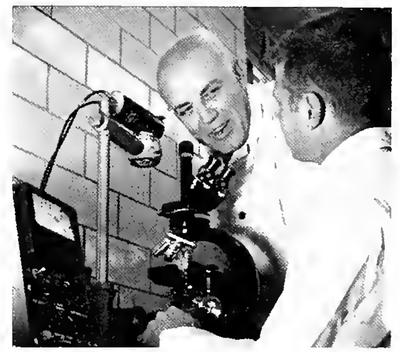
NEWS AND VIEWS



"Training tomorrow's scientists."

Training tomorrow's scientists. The orderly growth of research in all phases of our national economy depends upon having enough adequately trained scientists. Because we are part of a great university strongly committed to excellence and to graduate education, the Illinois Agricultural Experiment Station can play a major role in training tomorrow's agricultural scientists. During the past year more than 400 graduate students were enrolled in agriculture at the University of Illinois, and 60 percent of them received financial support from Experiment Station funds.

Swine research laboratory. Contracts have been approved for constructing the first units of a new swine research center on A.T. and T. road south of the campus. When the new facility is completed, the present swine farm and its antiquated buildings can be vacated. The swine research center is the first step in a long-range plan for modernizing our South Farm research facilities. When implemented, the plan will release badly needed land for the southward expansion of the campus.

Agricultural research and public health. Because our society is becoming more complex and interdependent, it is virtually impossible to separate agricultural problems from those of other segments of society. As an example, the recent events involving pesticides emphasize the close interaction of agricultural technology and public health. Other examples include the diseases which are common to man and to livestock, water pollution and farm waste disposal, and the effects of production practices on the nutritional value of foods. These merely illustrate that agricultural scientists must be alert to the broader implications of their work and must maintain contact with their fellow scientists in many other fields. This we try to do. — *M. B. Russell*

Now You Can Control Quackgrass

E. L. KNAKE and D. L. MULVANEY

MANY FARMERS in northern Illinois find that quackgrass is the most serious perennial grass they have to cope with.

It is spread both by seed and by vigorous underground stems called rhizomes. These white to straw-colored rhizomes can produce new plants at each joint or node so that the weed rapidly forms a dense sod.

For many years cultivation was about the only means of control. Some good can be accomplished with tillage practices that expose the rhizomes to drying in summer and to freezing in winter. Or the top growth can be removed, causing the plant to use up its food reserves and gradually starve to death.

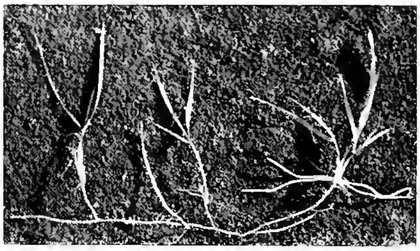
These methods, however, are only partly successful. It is difficult to expose all the rhizomes. And cultivation to remove the top growth must be frequent so that the leaves never grow beyond 2 or 3 inches. Too few cultivations may actually rejuvenate the rhizomes so that they penetrate more deeply and become even better established. But frequent cultivation is costly, it may interfere with crop production, and it seldom gives complete control.

Three chemicals tested

Fortunately, new chemicals are now available which allow profitable crop production while killing quackgrass. Their effectiveness and economy has been demonstrated by research at a University of Illinois experiment field near DeKalb.

The herbicides tested were atrazine (Atrazine 80W), amitrole-T (Amitrol-T and Cytrol), and dalapon (Dowpon). These chemicals were applied at various rates, at different times, and in various combinations to determine the most effective and practical control.

The area used for the experiment had been uniformly and heavily infested with quackgrass for several years. Spray treatments were applied in the fall of 1961 and the spring of 1962. Corn was grown on all plots in 1962. Corn yields and the degree of weed control for that year are shown in the table on page 4.



New shoots arise from rhizomes growing laterally beneath the soil surface.

Atrazine effective

Atrazine controlled quackgrass exceptionally well. Quackgrass absorbs atrazine through both leaves and roots. Inside the plant, atrazine disrupts the manufacture of food. As the food reserves of the plant are depleted, the quackgrass weakens and dies. Fortunately, while quackgrass is very sensitive to atrazine,

Check plot — no control of quackgrass.

Quackgrass controlled with 5 pounds of Atrazine 80W.

corn has very good tolerance to this herbicide.

As shown in the table, atrazine can be used in several ways. The fall treatment with 5 pounds of Atrazine 80W gave the best control of quackgrass. But the split application (2½ pounds applied to actively growing quackgrass in the spring and 2½ pounds applied as a preemergence treatment when corn was planted) controlled quackgrass nearly as well and controlled annual weeds better.

Both the fall treatment and the split application controlled quackgrass slightly better than the single spring application of 5 pounds of Atrazine 80W. Another advantage of the fall treatment is that the atrazine has more time to decompose.

Amitrole-T safer

When used alone, amitrole-T did not control quackgrass as well as atrazine. But it has the advantage of decomposing faster in the soil.

Five pounds of atrazine is a relatively high amount. Although corn has excellent tolerance to atrazine, crops like oats and soybeans can be damaged if excessive amounts of atrazine are carried over in the soil. When a reduced rate of atrazine is advisable, it can be combined with amitrole-T to give reasonably good control. One gallon of amitrole-T (2 pounds active ingredient) is applied to actively growing quackgrass in the spring. The area is plowed 10 to 14 days later. As soon as corn is planted, 3¾ pounds of Atrazine 80W is broadcast as a preemergence application.

Dalapon a possibility

Although dalapon did not control quackgrass as well as some of the other treatments, there is little danger of crop damage if the recommended rate is applied early in the fall. With spring applications, there is a possibility of damage to corn unless there are 4 or 5 weeks of warm, moist weather between application and planting.

Use of dalapon is feasible in the fall when a crop susceptible to atrazine, such as soybeans, will be planted the next spring.

Effects on oats

In 1963 oats were planted on the plots that had been treated in 1961-62. Growing oats so soon after treatment is not recommended; corn should be grown a second year to avoid problems with atrazine residue. However, we wanted to see how much damage might occur if oats were planted the year after application.

The lowest yields occurred where quackgrass had not been controlled (see table). There was no quackgrass-free plot that had not been chemically treated, so we do not know what the yield might have been without either quackgrass or a chemical. It is clear, however, that quackgrass lowered yields much more than any possible carryover of chemical.

Precautions necessary

Although atrazine now makes good control of quackgrass a reality, certain precautions should be taken with its use.

Fortunately, both corn and quackgrass help to decompose atrazine. But if recommended rates are exceeded or for some other reason excessive amounts of atrazine remain in the soil, crops other than corn may be damaged.

If quackgrass is mostly in patches rather than in uniform stands, spray only the patches. Spraying where there is no quackgrass to aid decomposition could lead to problems.

Be sure the sprayer is working properly, agitating the wettable powder well in the tank, and applying it uniformly on the field at the proper rate. Don't overdose by lapping or covering the same area more than once. Shut off the sprayer in plenty of time when stopping or turning. Maintain the proper speed. Slowing down or speeding up on hills can cause a variation in rate.

A second crop of corn should be raised with no additional atrazine before planting other crops.

Rates of atrazine reported here were for a dark clay loam soil relatively high in organic matter. For sandy soils and other light-colored soils low in organic matter, the rate of atrazine should be reduced in accordance with label specifications.

Never use atrazine for controlling quackgrass in lawns.

Research is being continued on the effectiveness of chemicals for quackgrass control and the possible residual effect of these chemicals on later crops. But results thus far indicate that with the effective and economical chemical treatments now available, quackgrass need no longer be a problem in northern Illinois.

E. L. Knoke is Associate Professor of Weed Extension; D. L. Mulvoney is Assistant in Soil Fertility.

Weed Control and Corn and Oat Yields Following Various Treatments Made in the Fall, 1961, and Spring, 1962

Treatment	Time of application	1962 corn yields, bu./A.	1962 weed control[a]		1963 oat yields, bu./A.	1963 quackgrass control[a]
			Quackgrass	Annuals		
5 lb. Atrazine 80W	Fall	80.3	10	9	46.7	10
2½ lb. Atrazine 80W preplow plus 2½ lb. Atrazine 80W preemergence	Spring	78.1	9	10	52.1	9
5 lb. Atrazine 80W	Spring	66.5	8	7	31.2	9
1 gal. amitrole-T plus 3¾ lb. Atrazine 80W preemergence	Spring	50.3	8	9	39.5	7
8 lb. Dowpon preplow	Spring	46.0	7	0	43.7	7
2 gal. amitrole-T preplow	Spring	32.2	5	0	27.8	5
Check — no control of quackgrass		15.2	0	0	19.8	0

[a] Weed control ratings range from 10, very good, to 0, no control.

NMR, A New Corn-Breeding Tool

D. E. ALEXANDER

UNTIL RECENTLY, an analytical "bottleneck" has hampered breeding and genetic studies on oil content in corn and soybeans. Analyses could not be made without destroying the sample. Moreover, the cost of analyzing a sample was high.

This bottleneck, however, has been removed by a breakthrough in analysis that occurred in 1960. Scientists from Corn Products Company and the University of Illinois found that spectra from wide-line Nuclear Magnetic Spectroscopes — "NMR" for short — were associated with oil content of bulk samples of whole kernel corn. NMR analyses were non-destructive, rapid, and accurate.

Furthermore, with NMR the oil content of a single kernel could be determined without impairing viability. High-oil kernels transmit high oil content to their offspring. Since "elite" high-oil kernels need no longer be sacrificed in the analytical process, they could be saved for the "breeding herd" and their superior qualities transmitted to succeeding generations.

The advantages of NMR analysis can be compared with the advantages of back fat measurement in swine. Boars having thin back fat can be identified by biopsy, and the superior ones used for breeding. Were it necessary to slaughter in order to measure back fat thickness, it would be of little consolation or interest to the swine breeder to know that deceased boar 86 had the thinnest back fat ever recorded.

How NMR works

How does NMR permit scientists to measure oil content in whole seeds? The principles were first voiced by two physicists, Purcell of Harvard and Block of Stanford University, early in 1946. (They later won the Nobel Prize in physics for their discovery.)

Using Nuclear Magnetic Spectroscopes, plant breeders can measure the oil content of individual corn kernels without impairing viability. Here D. E. Alexander, Professor of Plant Genetics, watches Ralph Rodgers, Crops Testing Technician, put a 25-gram sample of whole kernels into the NMR unit.

They found that the nuclei of atoms could absorb energy from particular radio frequency beams. Hydrogen nuclei, for example, absorb energy from 7.3-megacycle beams. If 7.3-megacycle radio beams were directed into a sample of whole kernel corn, the amount of energy absorbed in a particular unit of time is proportional to the number of hydrogen nuclei in the sample.

Energy absorption of hydrogen nuclei in liquids differs from that in solids such as starch or protein. This difference is great enough that solids and liquids can be separately identified. Since oil in corn is a liquid and since oil is partly composed of hydrogen, the hydrogen content of a sample's liquid component is proportional to oil content. That is, NMR "counts" hydrogen nuclei in the liquid; then by dividing the total number of these nuclei by the average number of hydrogens per molecule of oil, the total number of oil molecules can be determined.

The actual operation of NMR is simple. A well-dried sample is weighed, poured into a test tube, and placed in the machine. A switch is flipped and one minute later the oil content is printed on a strip chart. The corn is removed, and may be planted in the greenhouse or field for further experimentation.

Aims of breeding programs

Since oil is 2¼ times as high in energy as starch, increases in oil content of hybrid corn without concomitant reductions in yield would result in higher acre yields in terms of energy. If animals were fed higher oil corn, greater gains per bushel could be expected.

NMR analyses are now making it possible to (1) create new breeding populations possessing high oil content, and (2) produce inbreds (parents of hybrids) combining high oil and high yield.

BETTER FORAGE for India's Dairy Cattle

E. E. ORMISTON

Professor Ormiston served as dairy science and extension adviser at Banaras Hindu University from March, 1961, through July, 1963. His assignment was part of a cooperative program whereby the University of Illinois is helping the Indian states of Uttar Pradesh and Madhya Pradesh to increase their food production. University specialists work as advisers in India, while Indian scholars come to Illinois for advanced study. The program is financed by a contract with the United States Agency for International Development (AID).

In India, a land where one-fourth of the world's cattle and buffaloes roam, a quart of milk costs half of an average man's daily wage.

Production costs are high primarily because feed is scarce. The shortage of roughages and grasses is particularly acute during the winter or dry season. Such roughage as is available is low in nutrient value and the cost is prohibitive in terms of the milk produced. It consists mainly of straw from rice, wheat, and barley, and the headless stalks of sorghum or millet.

While dairy adviser at the College of Agriculture, Banaras Hindu University, I sought ways of increasing the supply and quality of feed during the dry season. One obvious approach was to grow higher yielding forage crops; another was to improve preservation methods.

With the cooperation of S. L. Singal, Dairy Superintendent, and V. N. Bhargava, Lecturer in Dairy Science, a series of experimental plots was set aside for forage-crop trials.

Sorghums

In June, 1961, we planted two U.S. varieties of forage sorghums and a local white variety. Each variety was both broadcast and grown in rows. Because of excess water and a lack of tools for cultivation, the rows were inadequately cultivated.

Under the conditions of this demonstration, the broadcast plots outyielded those in rows. The U.S. varieties were noticeably leafier, had sweeter juices, and yielded better than the local variety.

The next year three U.S. varieties and the local variety were planted in rows and broadcast. Again the U.S. varieties outyielded the local one (see table). Variations in soil conditions accounted for some of the differences among the U.S. varieties and between the row plots and broadcast plots. All varieties had markedly larger heads and yielded more grain when grown in rows than when broadcast.

After the heads were harvested as grain, the stalks were chopped and fed. The cattle preferred the U.S. varieties, probably because of the higher proportion of leaves and the sweeter stalks.

Sudangrass

Sweet Sudangrass seed from the United States was planted broadcast on June 13, 1962, on fertilized plots. A plot harvested August 8 yielded 370 maunds (15.2 tons) per acre green weight; an adjacent plot harvested August 18 yielded 480 maunds (20.7 tons). A good second growth came up on each plot.

SX-11, a hybrid Sudangrass from the United States, was seeded in February, 1963. It made excellent growth, was cut in May, and made excellent second growth.

These tests demonstrated that U.S. varieties of Sudangrass are adapted to Indian conditions and that they yield well if they are irrigated during the dry season or make excellent growth during the monsoon season.

Calculated Sorghum Yields, 1962

Variety	Broadcast		Rows	
	Green wt.	Dry matter	Green wt.	Dry matter
	tons per acre			
FSIA	21.14	6.60	22.84	6.69
NK x 3065	25.55	8.15	19.55	5.75
NK 300	28.21	8.51	24.56	5.62
Local	1B.75	8.39	9.01	3.99

Corn performance

Corn is generally considered to be a monsoon crop in India, but yields are generally low, mostly because of poor drainage and heavy rain.

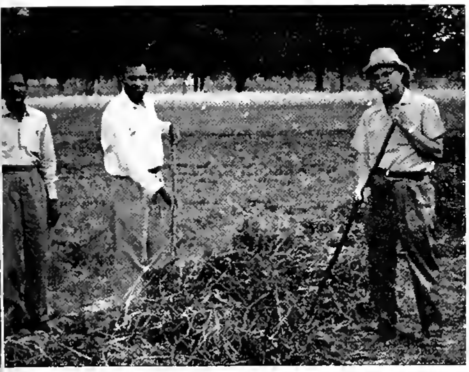
After I had successfully grown sweet corn in my garden in February, a colleague, Dr. V. N. Bhatnagar, became interested in growing field corn during the dry season. Hybrid corn (Ganga 101) was planted in four replicates on January 25 and February 1, 8, 15, and 22, 1963. The kernels were dropped at 12-inch intervals in 24-inch rows. Fertilizer was applied at the rate of 100 pounds of nitrogen, 40 pounds of potassium, and 60 pounds of phosphorus per acre. Plots were cultivated twice, kept free of weeds, and irrigated.

Yields were about twice as high as those usually obtained on the college farm during the monsoon season, demonstrating that corn will grow well during the dry season if irrigated and fertilized.

Cropping sequence

The college dairy farm had traditionally grown two crops a year. During the winter, barley, pidgeon peas, or gram were grown on nonirrigated land; barley, wheat, oats, and a small acreage of berseem were grown on irrigated land. During the monsoon season, millet, sorghum, and sometimes corn were grown for grain and fodder.

In a cooperative experiment, the dairy and agronomy sections demonstrated that, with careful plan-



Professor Ormiston (right) cocking hay with two of his Indian colleagues.

An above-ground brick, cement-plastered silo is filled with whole stalks of sorghum and millet.

ning, three crops a year can be grown on irrigated land. The experimental plan called for two consecutive crops of corn, sorghum, or millet, followed by berseem in the winter.

Hybrid corn (Ganga 101), a local white variety of sorghum, and pearl millet were planted in 18-inch rows in three separate blocks. Each block had three plots of corn, two of sorghum, and one of millet. Ammonia sulphate was applied at the rate of 10 pounds of nitrogen per acre in each of two applications. Weeds were controlled and the plots were irrigated as needed.

The crops were planted May 6-11 and were harvested July 10-21 when the corn was in flower but before the sorghum and millet had flowered. Average acre yield of green fodder was 208 maunds (8.5 tons) for corn; 735 maunds (29.6 tons) for sorghum; and 450 maunds (18.4 tons) for millet.

A second seeding of these crops was prevented by the onset of heavy monsoon rains. This experience taught us that the first planting should have been made in early April so that the second planting could have been made before the monsoon.

As a result of these experiments, the cropping system of the college dairy farm was changed so that the irrigated area now produces green feed the year round.

Methods of forage preservation

The usual methods of preserving forage in India are to store straw in a protected place until needed, and to stack sorghum and millet fodder around a tree or pole or against a building. The fodder is of low quality because the sorghum and millet are harvested for grain when mature and the dry stalks may stand for several weeks before they are cut. Silage- and hay-making are rare.

High-quality forage, however, can be preserved in India. Weather conditions are excellent for this purpose through much of the year. Only in the three-month monsoon season is it impossible to dry forage.

Berseem hay

By trial and error, a procedure was developed for making excellent, leafy green hay from berseem, a rapidly growing leafy legume which thrives during the winter on irrigated land. If it is seeded in early September, four or five cuttings may be harvested from December to April. The crop is usually chopped and mixed with straw or fodder from sorghum or millet.

The main problems in making hay from berseem are that the stems are very high in moisture and the leaves are thin, shattering badly. To keep moisture at a minimum, we withheld irrigation for three or four days before the hay was cut. The crop was cut by hand and laid in small windrows. In four to six hours the top leaves were well wilted, and the windrow was turned. When the leaves on the turned hay had wilted it was put into small cocks. After the stems were dry, usually within a day, the hay was removed from the field and stacked near the barns. This procedure was varied after the first year by drying the freshly cut crop on the barn roofs. The hay was excellent if turned before the leaves were dry enough to shatter or become sunburned.

Sorghum and millet fodder

Sorghum and millet are major sources of fodder in India, but much of their nutritive value is lost because of excess weathering. Also birds may get much of the seed.

Drawing on boyhood experiences of cutting corn fodder, I tried a similar method with sorghum and millet. The crops were cut when the grain was in the late dough stage, before bird damage was heavy, and put into small piles to dry for a few days. To leave the field free for the next crop, the fodder was taken to an uncultivated area for further curing in loose shocks. This method preserved the grain and produced a leafy fodder with a good color and very little mold.

Silage

Making silage offers great opportunities for preserving and storing high-quality roughage in India. However, the water table is too high in many areas to permit pit silos, and power and machinery are not available to fill tower silos.

To circumvent these problems, we built a horizontal, above-ground brick silo, 14 feet wide, 40 feet long, and 8 feet high. Because of delay in obtaining a power-driven chopping machine, the silo was filled with whole stalks of sorghum and millet cut in the early to late dough stage. The stalks were laid straight and packed tightly with the butt ends exposed at each end of the silo. The resulting silage was tobacco-brown, had an excellent aroma, and was highly palatable to the cows.

This experiment, like the others we tried, demonstrated that it is possible to provide more and better feed for India's dairy cattle and thus produce more milk for her people.

FREEZING CRANBERRIES: Effect on Pectin Content, Gel Formation and Palatability

NANCY O. KEPPLER and FRANCES O. VAN DUYNE

Cranberries have been frozen for the commercial production of canned sauce for more than 30 years. Research at the University of Massachusetts has indicated that color, flavor, and gel strength are as good in sauce made from frozen berries as in that made from fresh berries. Directions for freezing cranberries have appeared in popular publications. Recently cranberry producers have been recommending that cranberries be frozen in the plastic bags in which they are packaged for the retail market.

In spite of these facts, few data have been published that will answer these questions: Is total pectin content of cranberries affected by freezing and freezer storage? Should cranberries be repackaged in moisture-vapor-proof containers before freezing? Should the method of preparing gelled cranberry sauce be modified when frozen rather than fresh berries are used?

A study to obtain information on these questions was therefore undertaken as part of our continuing research on chemical and physical changes in frozen foods.

Procedures

Four lots of cranberries were purchased during the 1961-62 season and four additional lots, in November 1963. Some 1-pound packages from each lot were frozen as purchased, without washing, sorting, or repackaging. These berries will be referred to as prepackaged. Other berries were washed in water and dried on towels, and the spoiled ones were discarded. Samples of these cranberries were repackaged for freezing in polyethylene bags which were sealed tightly and placed in cardboard freezer boxes. The remaining berries in each lot were used for the preparation of sauce and for chemical determinations.

Nancy O. Keppler is an Assistant in Home Economics; Frances O. Van Duyne is Professor of Foods. This paper is based on work that Mrs. Keppler did for her M.S. degree, plus additional research.

In the first or 1961-62 series of experiments the frozen cranberries were stored for 8 and 16 weeks. In the second series they were stored for 13 and 26 weeks, since the longer storage period might occur more frequently in many households.

To prepare cranberry sauce, equal weights of cranberries and boiling water were boiled in a heavy saucepan over medium heat for about 20 minutes. The hot berries and juice were pressed through a stainless steel strainer. Six hundred grams (2½ cups) of strained slurry, slightly less than the amount obtained from a pound of cranberries, were boiled gently for 3 minutes; 400 grams (2 cups) of sugar were added and boiling was continued about 2 minutes, or until the sauce contained between 43 and 47 percent soluble solids.

The total soluble solids (as sucrose) of the slurry without sugar, and of the hot sauce containing sugar, were measured with the Abbé refractometer. After the final heating the sauce was poured into straight-sided ½-pint jars and into three aluminum crystallizing dishes, then refrigerated for 20 hours.

Gel strength determinations using a Bloom gelometer were made on the samples in the crystallizing dishes, while the sauce in the jars was unmolded and rated for palatability. Four to six members of the food research staff scored the appearance, color, consistency, and flavor on a 5-point basis with 5 corresponding to very good; 4, good; 3, fair; 2, poor; and 1, very poor. Scores for the four characteristics were added to obtain a total palatability score.

Mrs. Keppler measures gel strength of sauces with a Bloom gelometer.

Moisture and pectin content

In Table 1 may be found mean values for the moisture and total pectin content of fresh cranberries and of stored, frozen berries which had been packed in the laboratory. It is interesting that the moisture content of the 1961-62 berries increased significantly (5-percent level) during freezer storage, although the increases were too small to be of practical importance.

Pectin, a carbohydrate polymer of galacturonic acid units, was extracted and determined by methods developed at the Western Regional Research Laboratory. In both series the total pectin content was significantly lower in the frozen stored berries than in the fresh ones. Total pectin content of the slurry was also determined in the first series.

Mean percentages of pectin were 0.26 for slurries prepared from fresh cranberries; 0.24 and 0.20 for slurries from frozen berries stored 8 and

Table 1 — Mean Values for Moisture and Total Pectin Content of Cranberries

Cranberries	No. of lots	Moisture content	Pectin content[a]
		pct.	pct.
Fresh, as purchased	4	87.6	0.73
Frozen, stored 8 wk.	4	87.9	0.65
Frozen, stored 16 wk.	4	88.0	0.59
Fresh, as purchased	4	86.8	0.74
Frozen, stored 13 wk.	4	87.5	0.58
Frozen, stored 26 wk.	4	87.7	0.50

[a] Determined as galacturonic acid by a carbazole method.

Table 2 — Mean Values for Soluble Solids Content and Gel Strength of Cranberry Sauce

Cranberries used for preparing sauces	No. of lots	Soluble solids[a]	Gel strength[b]
		pct.	gm.
Fresh, as purchased	4	45.6	126.2
Frozen, stored 8 wk.	4	44.7	110.0
Frozen, stored 16 wk.	4	45.0	105.0
Fresh, as purchased	4	46.0	104.8
Frozen, stored 13 wk.	4	45.4	115.4
Frozen, stored 26 wk.	4	44.9	94.1

[a] Soluble solids content of hot sauce.
[b] Gel strength after sauce was refrigerated 20 hours.

Table 3 — Mean Palatability Scores for Gelled Cranberry Sauce

Cranberries used for preparing sauces	No. of scores in means	Scores for individual palatability factors[a]				Total scores[a]
		Appearance	Color	Consistency	Flavor	
Fresh, as purchased	18	4.9	4.9	4.7	4.8	19.3
Frozen, stored 8 wk.	20	4.4 (4.4)	5.0 (5.0)	4.4 (4.2)	5.0 (4.8)	18.7 (18.4)
Frozen, stored 16 wk.	24	4.9 (4.3)	4.9 (5.0)	4.6 (3.9)	4.8 (4.7)	19.2 (17.8)
Fresh, as purchased	16	4.9	5.0	4.6	5.0	19.5
Frozen, stored 13 wk.	16	5.0 (4.6)	5.0 (5.0)	4.9 (4.6)	4.9 (4.9)	19.9 (19.1)
Frozen, stored 26 wk.	16	4.5 (4.6)	5.0 (4.8)	4.5 (4.2)	4.9 (4.8)	18.9 (18.4)

[a] Scores for the sauces made from berries packaged for the retail market and frozen without repackaging are given in parentheses beside comparable scores for sauces from berries frozen after sorting and repackaging in the laboratory.

16 weeks, respectively. Although there appeared to be slight decreases with storage, these differences were not statistically significant. Only 34 to 37 percent of the pectin in the fresh and frozen berries (see Table 1) was accounted for in the slurries. Whether the pectin was not all extracted from the slurry or whether it was destroyed during preparation of the slurry is not known.

Soluble solids and gel strength

Percentages of soluble solids were measured in the slurries prepared from fresh cranberries and from berries that had been frozen and stored after being repackaged in the laboratory. The range in percentage was from 5.6 to 6.2 in the first series of experiments and from 5.7 to 6.6 in the second series. However, the increases after freezing and storage were not statistically significant. After the addition of sugar, the mean contents of soluble solids in the hot sauces ranged from 44.7 to 46.0 percent (Table 2). This is higher than the range of 38 to 40 percent usually recommended for commercially canned cranberry sauce.

Mean values for the gel strengths of refrigerated sauces as measured with the Bloom gelometer are given in Table 2. Although the means for sauces made from frozen berries (except those stored 13 weeks) were lower than the means for comparable freshly prepared sauces, the differences were not statistically significant.

Within each series, considerable variation in gel strength was found among different lots of berries. In the first series, values ranged from 69.6 to 136.2 grams; in the second series, from 62.7 to 133.0 grams.

Values below 70 grams were considered too low for a moderately firm, desirable gel. Mean values lower than 70 were found in the sauces from one lot of stored, frozen laboratory-packaged berries and three lots of stored, frozen prepackaged berries. When rated by the taste panel for consistency, these sauces had mean scores slightly below 4.0 (good).

Palatability of sauces

Mean palatability scores for gelled sauces prepared from fresh cranberries were 19.3 and 19.5 out of a possible 20 (Table 3). Scores ranged from 18.7 to 19.9 for sauces made from berries repackaged in the laboratory before freezing; from 18.4 to 19.1 for sauces made from prepackaged frozen berries. It is evident that products rating between good and very good were obtained from stored frozen berries.

In 10 out of 16 comparisons of mean scores for individual palatability factors, sauces from frozen berries which had been repackaged in the laboratory were rated higher than frozen prepackaged berries. The greatest differences were in the consistency scores. Those for sauces from repackaged berries ranged from 4.4 to 4.9; from prepackaged berries, from 3.9 to 4.6.

Recommendations

Cranberries should be frozen when the fresh berries are at optimum quality. Washing, sorting, and repackaging cranberries in moisture-vapor-proof bags before freezing is recommended. Cranberries that were frozen in the retail packages lost weight during freezer storage, and it was difficult to identify spoiled berries when all were frozen. Also, if the mean scores of the sauces prepared from repackaged and prepackaged berries differed, the scores of the former were generally higher.

In this study good gelled sauces were obtained by using the same method for fresh cranberries and for frozen berries held in freezer storage as long as 26 weeks. Firmer gels than those described here were prepared by further concentrating the slurry made by boiling cranberries and water together. It is reasonable to expect that other recipes and procedures would give equally good products when frozen cranberries are used.

Valuable New Tools for Wood Research

C. S. WALTERS

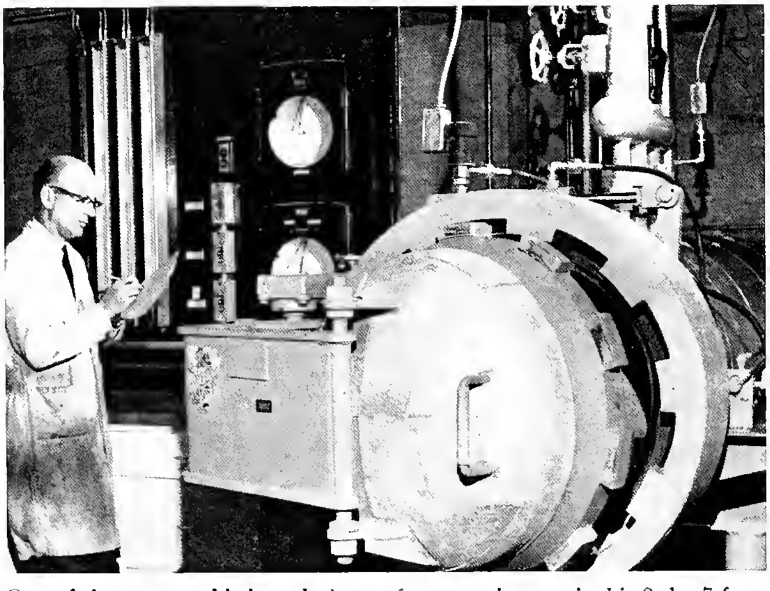
Wood is one of our most important raw materials. It is readily available and universally used, and the supply is practically inexhaustible when the forest is tended carefully.

Although Illinois ranks fairly low as a timber producer, she ranks very high among the states in the manufacture of products from wood. Every year Illinois manufacturers convert 2 billion board feet (about 90 percent imported) into usable products. The wood conversion industry represents a capital investment of millions of dollars and provides jobs for thousands of workers.

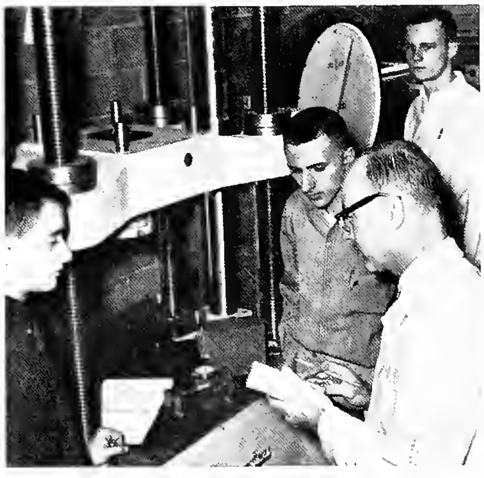
Because wood has rather unusual properties, manufacturers often encounter technical problems in cutting, seasoning, gluing, or finishing it; in keeping it from shrinking or swelling; and in protecting it from fire, decay fungi, or insects. Many of the problems can be solved by the scientist who has a basic understanding of wood's complex molecular structure, its physical and mechanical properties, and the ways in which it should be used — or not used. However, much more needs to be known.

The research facilities shown on these pages have been recently acquired by the Department of Forestry so that we can find ways of making wood serve mankind better, longer, and more economically.

Professor K. R. Peterson tests the toughness of a wood specimen. A second specimen is in position for the impact-bending force which is applied through the chain. This test shows the quality of wood, since decay or low specific gravity can be detected by the amount of kinetic energy a sample will absorb.

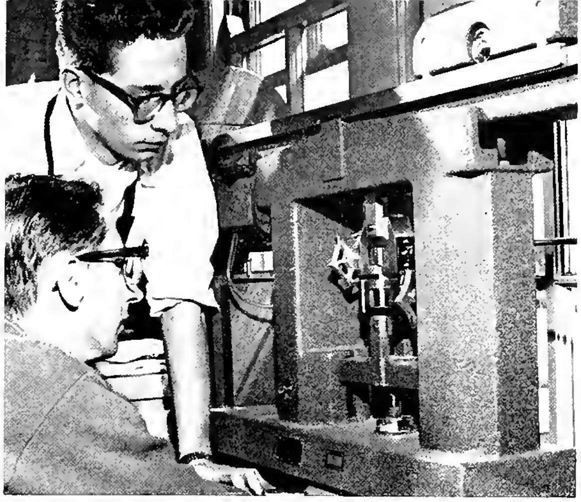


One of the most sophisticated pieces of new equipment is this 2- by 7-foot, steel cylinder in which wood specimens can be steamed, heated in liquids, or treated with various chemicals applied by vacuum-pressure methods. Only one other unit in the United States approaches the research capabilities of this unit. Pressures ranging from vacuums as low as 28 inches of mercury to 800 pounds per square inch (over 50 times atmospheric pressure) can be developed within the cylinder. The long gages on the instrument panel in background measure the amount of chemicals stored in tanks; the three switches control pumps; and the round charts show the temperature of liquids and the vacuum or pressure conditions inside the cylinder. The round, black, solenoid valve at the top of the cylinder door is one of several safety devices.



This machine measures the compressive or tensile strength of wood. Loads up to 120,000 pounds can be applied to specimens, either parallel to the grain or at right angles to it. Here students are studying the compressive strength of a short red-oak column.

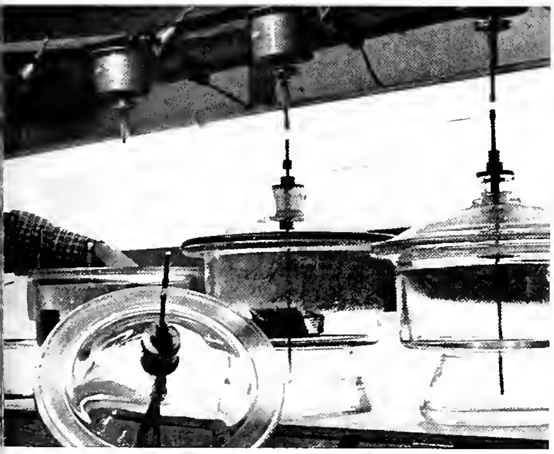
C. S. Walters (shown in picture at left) is Professor of Wood Technology and Utilization, Department of Forestry.



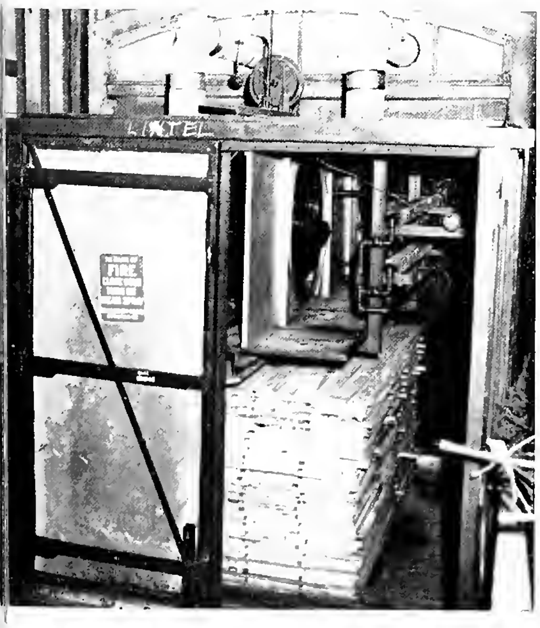
...res of plywood are made in this ...ry press when pressure is applied ...s of veneer held between heated ... the glue bond is tested in shear ...ure). Such studies provide infor... strength of glues and on the way ...emperature affect glue bonds.

Two students test the strength of glue lines in a plywood specimen. The specimen is clamped between the jaws of the machine and is subjected to a tensile force when the poise weight (upper right) is rolled across the top of the machine by a constant-speed motor. The load is measured when either the wood or the glue bond fails in shear.

This mercury meter measures the volumes of small samples of wood, often borings taken from trees. The samples are put into the cylinder, the crank is turned, and the amount of mercury displaced within the instrument is read from the scale on the horizontal cylinder. Specific gravity, calculated from the volume and weight of the specimen, is used to study strength properties, pulp yield, or the ways in which changes in the tree's environment affect the properties of the wood.



A student laboratory assistant removes samples of wood from a constant-humidity chamber so he can measure their dimensions. Constant-humidity chambers make it possible to study shrinkage and swelling of wood under controlled environment. Each chamber is maintained at a different relative humidity — some low, some high — with saturated solutions of chemicals. Chambers are kept in a box-like compartment at a constant temperature. The motors circulate air in the chambers and stir the solutions.



A dry-kiln for seasoning green lumber (second picture to the left) was custom-built for the University. It has the basic features of large commercial units but can dry small amounts of lumber for tests. The controls on the instrument panel automatically record and maintain relative humidity and air temperature in the kiln. A large fan inside the kiln circulates "conditioned" air through about 800 board feet of lumber — in this instance, green cottonwood.

Professor J. K. Guiher slices thin sections from a sample of wood for microscopic examination. The sliding microtome will cut sections about one-fifth as thick as this page.

Studies of normal and abnormal
BONE MATURATION IN HORSES

HARRY HARDENBROOK, JR.

EVERY YEAR the staff of the large animal clinic of the University of Illinois treats several hundred horses for some kind of bone disease.

Bone diseases are especially serious in horses. Since bone is one of the main supporting tissues, abnormalities of the bone may interfere with normal movement. And power of movement is the chief of the characteristics that give the horse a place in our economy.

Because of the importance of bone diseases in horses, one wonders why they haven't been studied more in the past.

Types of bone disease

Bone diseases may be classified into six major groups:

1. Diseases associated with defective bone formation, or with abnormally soft or brittle bones. Examples are adolescent rickets, celiac rickets, osteomalacia.

2. Diseases associated with overgrowth of bone. Examples are pulmonary osteoarthropathy, multiple cartilaginous exostoses, acromegaly.

3. Diseases due to infectious agents such as Streptococci, Staphylococci, and coliform organisms. These organisms may cause clinical conditions which are named periostitis, osteitis, and osteomyelitis.

4. Diseases due to necrosis or death of the bone. Examples are caries, or molecular death of bone, and sequestrum formation, or death of a bone part that is grossly visible. An example of a specific condition occasionally seen is osteochondritis dissecans.

5. Tumors and cysts of bones, such as osteogenic carcinoma and osteoma.

6. Fractures of various types. These are usually the results of direct injury, or of injury brought about by too much muscular tension.

The most usual diseases of young horses are those in groups 1, 3, and 6. Among the horses brought to the large-animal clinic, most of the bone diseases have been caused by injury. When fractures have resulted from the injury, they have often been complicated by non-union or malunion of the bone and by serious injuries to soft tissue near the fracture. Examination often shows defects in bone development. Many veterinarians believe that these defects both predispose the animal to injury and retard his functional recovery.

What needs to be learned

When one considers the frequency of bone injuries and the associated faulty bone development, the relative importance of these two factors becomes a matter of speculation.

The cause of some abnormal states of bone development in young horses is not well understood. An important cause may be the nutritional state of the dam at a critical stage of bone development in the fetus. Or the pregnant mare may be exposed to disease-producing organisms that affect the development of fetal bone. The tendency toward abnormal bone structure may be inherited and therefore familial. Perhaps abnormal bone structure is due to faulty bone protein formation or faulty mineralization. Some rations may not furnish enough vitamin D.

Objective of study

A basic correlative study is now underway to obtain information about the prevalence, causes, and effects of defective bone development in young Thoroughbred horses, as well as possible corrective measures. Horses on a number of different farms will be studied from the time they are young foals until they are mature.

Data are being collected on organic and inorganic blood elements, presence of influenza and influenza-like viruses, effects of exercise, general circulatory efficiency, makeup of rations, and the X-ray architecture of bone and the changes it undergoes during the foal's growth.

Present state

The project has been but recently begun. To date, about 100 foals have been examined. Their ages at the time of the first examination have ranged from 2 to 5 months.

A definite variation in the bone quality of the various foals has been noted. On some farms the foals' bone development is generally good; on other farms it is relatively poor. It will be interesting to note whether further observations confirm this finding.

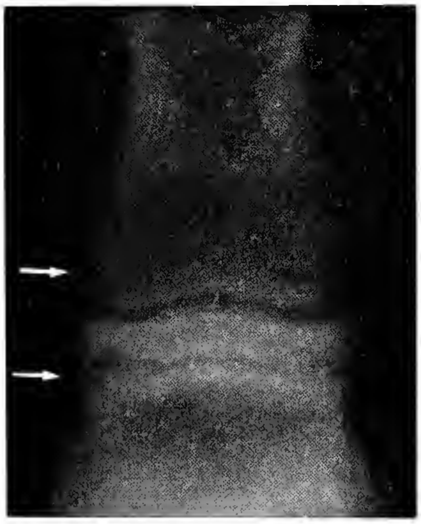
Blood analyses of protein and mineral constituents are becoming available but are not yet complete enough to be reported. Ration analyses will be available in the near future.

Antibodies against Parainfluenza III (bovine), Miami A, and Parainfluenza III (human) have been found rather frequently, but fewer antibodies have been found against the $A_2$170, the $A_2$635, and the $A_2$305 strains. Where antibodies are present, they indicate that the mare has

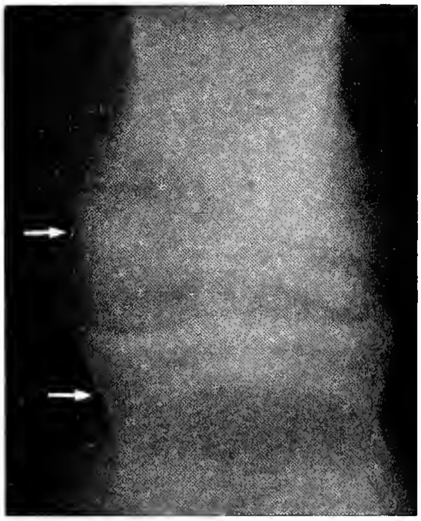
Harry Hardenbrook, Jr., is Professor of Veterinary Clinical Medicine and of Veterinary Physiology and Pharmacology.

The symmetrical forelegs of this 24-month-old colt indicate good bone development. (Fig. 1)

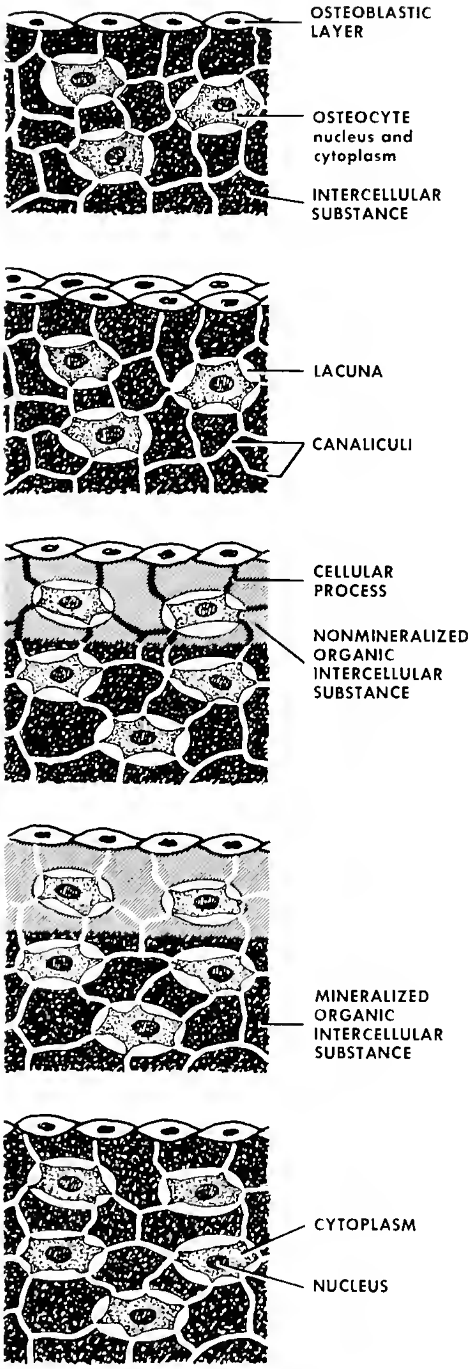
Disturbances in bone development around the epiphyses results in visible enlargement of carpal and fetlock areas. (Fig. 2)



X-ray of normal foreleg (4½-month-old foal). Lower arrow points to epiphyseal line of second phalanx, where osteoblastic layers are forming new bone as shown in Figure 5. Normal epiphyseal closure has occurred in distal end of first phalanx (top arrow). (Fig. 3)



This X-ray (7-month-old foal) shows an abnormal reaction in epiphyseal area of second phalanx (lower arrow). Bone is soft as indicated by the lips which have formed at joint surface. The epiphyseal line of distal end of first phalanx (top arrow) has not closed normally. (Fig. 4)



Schematic representation of appositional bone growth in area of the epiphysis (end of a long bone). The single layer of osteoblasts (bone-forming cells) shown in the top drawing multiplies to form a double layer (second drawing). Some of the osteoblasts then develop into osteocytes, or cells characteristic of mature bone (third drawing). The osteocytes exist in minute cavities known as lacunae. Canaliculi essential to the nutrition of the osteocytes develop between the lacunae (fourth drawing), and minerals are deposited in the organic intercellular substance (last drawing). (Fig. 5)

been previously exposed to specific influenza viruses. Tests for antibodies will be repeated to learn what different strains of influenza-like viruses have invaded the body.

Considerable variation has been observed in the levels of various cellular and noncellular blood components. No conclusions can be drawn, since data are still limited.

When enough data are obtained in the various areas to permit correlation, the resulting information should yield information of value to the horse breeder, nutritionist, and veterinarian. A correlative study of this type could even be of general value, increasing our understanding of bone pathology in other animal species, including man.

A Control for Unloading Silos Automatically

D. R. DAUM and H. B. PUCKETT

LABOR COSTS and shortages, as well as the desire for increased production per man, are forcing farmers to use automatic systems of feeding.

All components of an automatic system must be self-regulatory. Feed materials must be removed from storage, blended in the proper proportions, and conveyed to the feed bunk. In a recent cooperative project by the Department of Agricultural Engineering and the U.S. Department of Agriculture, a control was developed for a silo unloader, permitting silage delivery at an adjustable uniform rate.

Silage metered by weight

Silage metering can be by either weight or volume. Because of wide variability in silage density, weight appears to offer the more desirable method of control.

The first step in the design was to install two motors on the unloader, one to drive the impeller and another to drive the gathering auger. The current drawn by the impeller motor is a function of the silage mass being delivered (weight basis).

To obtain a maximum change in current for a given unloading rate, the impeller motor must have a near-unity power factor over the operating range. Silage flow can be measured on a weight basis by sensing the current demand of the impeller motor. For accurate control, the supply voltage must be constant.

Current meter relay

A current meter relay was installed to sense the current to the impeller motor (Fig. 1). The meter relay is a three-position floating control with a neutral zone between an upper and a lower operating position. Adjustable limits on the meter relay permit a wide selection of operating ranges. If the current demand is outside the present limits, a signal is sent to a reversible electric motor that powers a hoist to raise or lower the silo unloader, thus varying the depth of cut and hence the output. When the current demand is between the limits or in the neutral zone, the unloader does not move up or down.

The current meter relay is a D'Arsonval dc millivolt meter wired for ac operation and connected to the impeller motor circuit through a current transformer. It is calibrated in ac amperes.

Originally the normal vibrations in the building during operation caused the meter needle and contactor to vibrate. The electronic controller (thyratrons) responded to these vibrations, making the power relays chatter. The controller was modified by including a time delay in the grid circuit of each thyratron. This delay reduces the frequency at which the control can act. Short, temporary signals are nullified, most of the relay "chatter" is eliminated, and "hunting" is greatly reduced. As a result, operation of the unloader is more uniform.

Power winch

The power winch used to raise or lower the unloader consists of a steel drum driven by a ½-horsepower, reversible electric motor (Fig. 2). The drum rotates to pay out or rewind the unloader support cable at about 0.5 inch per second. In addition to regulating the unloader level during the feeding period, the winch lifts the unloader, on signal from the main control panel, at the end of the feeding cycle. This permits the unloader to clear and keeps the equipment from "freezing down" during cold weather.

Safety devices

As in most automatic systems, certain safety devices and controls are necessary. The presence or absence of silage in the conveying auger is detected by a silage-flow sensing switch. A mercury switch mounted on the silo-unloader discharge conveyor indicates when the unloader is too low. Another mercury switch on the same conveyor indicates when the unloader is too high. The current drawn by the motor driving the gathering augers and drive wheel is monitored by a meter relay (Fig. 1). If the amperage exceeds the preset limit, the relay will signal the system to stop.

Each safety device can stop the entire operation. At the same time, one of several indicator lamps on the main control panel lights up, indicating the location of the trouble. A warning lamp on top of the silo also lights when an unsafe condition arises and persists. This outside lamp aids in checking the system from a distance.

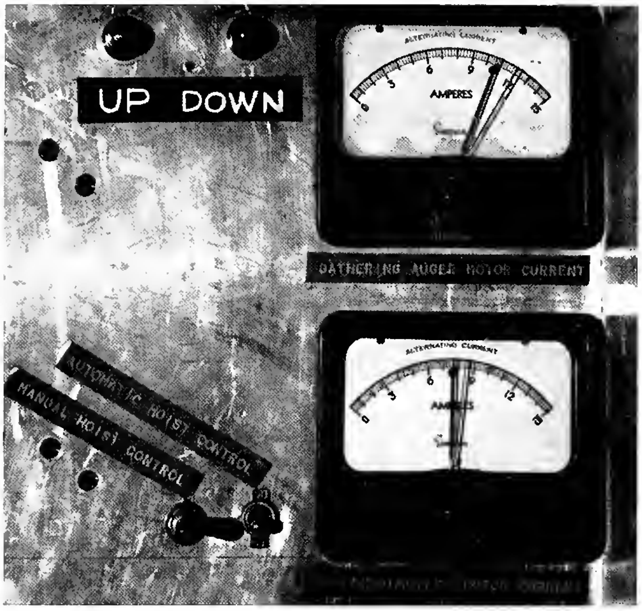
Tests at beef farm

The unloader controller was tested in a feeding system at the University beef farm. The silo unloader was a top-mounted unit (single-cable supported) in a concrete stave silo 12 feet in diameter. Corn silage was unloaded.

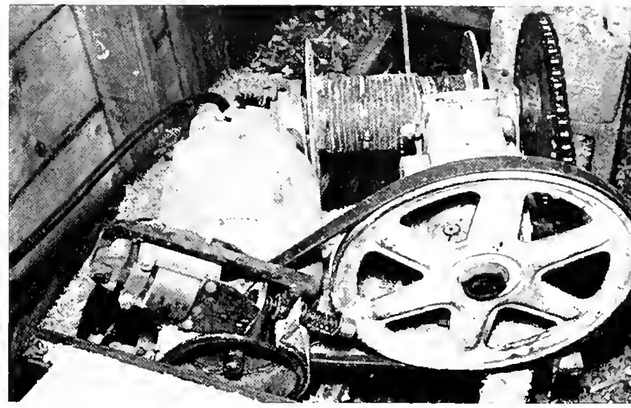
The original 3-horsepower motor on the unloader was removed and replaced by two motors (Fig. 3). A 1½-horsepower motor was mounted to drive the gathering augers and the drive wheel. The second motor was a two-value capacitor, 3-horsepower motor which drove the impeller only. It is the current to the second motor that is measured by the controller meter relay.

Current demand of the impeller motor was correlated with discharge rate between the limits of about 50 to 150 pounds per minute. The

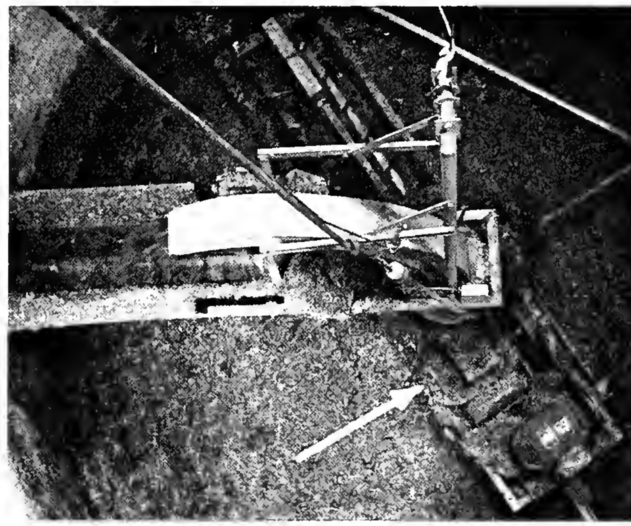
D. R. Daum is Assistant Professor of Agricultural Engineering and H. B. Puckett is Agricultural Engineer, Farm Electrification Research Branch, U.S. Department of Agriculture.



Current meter relays used to monitor gathering-auger motor (top) and impeller motor (bottom). (Fig. 1)



Power winch used to raise and lower silo unloader (top right). The brake, which is released during adjusting periods, prevents coasting. (Fig. 2)



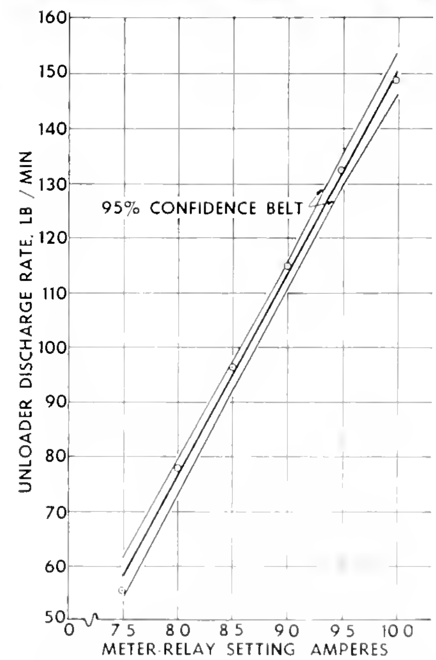
Two motors were used to operate the unloader. One drove the impeller (arrow) and the other powered the gathering augers and drive wheel. (Fig. 3)

upper limit was imposed by the unloader capacity. This range in delivery rate required 1 to 2 horsepower and corresponded to a current range of 7.5 to 10.0 amperes for the impeller motor.

The meter relay setting was increased 0.5 ampere at a time within the 7.5- to 10.0-ampere range. The time required to discharge 50 pounds of silage at each setting was determined. In all tests the differential was 1 ampere. That is, if silage delivery rate at 8.5 amperes was being tested, the limits of the meter relay were set at 8.0 and 9.0 amperes. If the motor current was outside this range, the controller would signal the winch to move the unloader in the proper direction for bringing the impeller-motor current demand within the ampere limits.

As shown in Figure 4, the correlation of current demand and silage delivery rate is a linear function with a 1-ampere change equal to a change in silage flow of 37.02 pounds per minute within the operating range. The 95-percent confidence limits are plotted to form an operating band. Each of the plotted points in Figure 4 represents the mean of twenty-four 50-pound sample runs. Note that the means are all well within the 95-percent confidence band.

Large variations occurred among the individual 50-pound samples largely because of the slow response of the controller. However, the variations were greatly reduced when the sample size was increased. With 1200-pound samples the mean delivery rate (104.3 pounds a minute) had a variation of 4.26 percent with 95-percent confidence. Thus the variation was less than the 5-percent error which was tolerated.



Calibration curve of silage flow rate vs. impeller motor current demand. (Fig. 4)

How Speed Affects Draft of Model TILLAGE TOOLS

DAVID J. OLSON

At present designers of tillage and earthmoving equipment have to rely on intuition and on trial and error, for very little is known about the basic soil-cutting process.

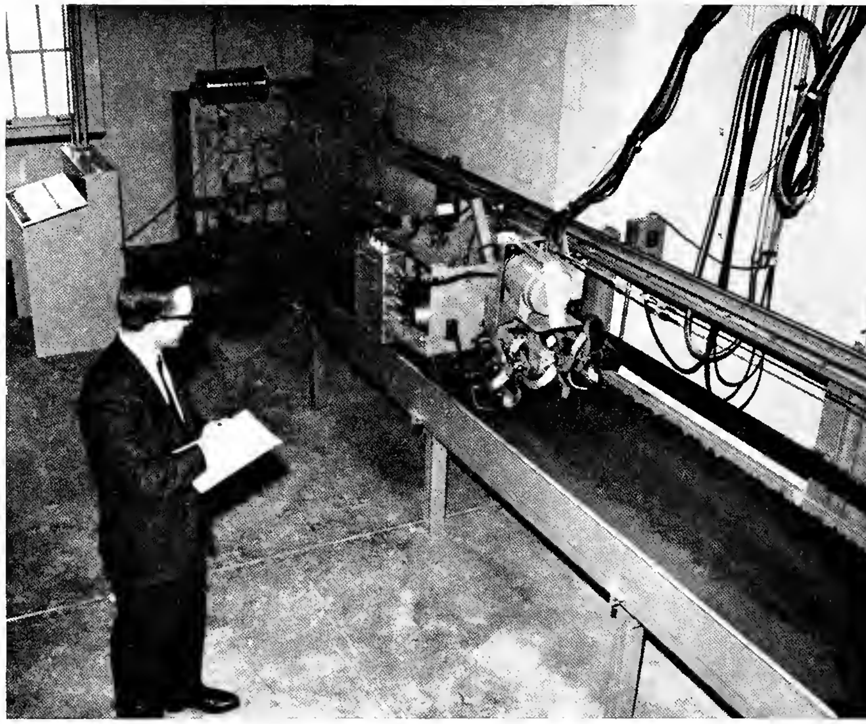
To correct this gap in our knowledge and develop a theory of soil dynamics, the Department of Agricultural Engineering is conducting experiments with model tools in an indoor soil bin.

The specific objective of one current study is to determine why an increase in speed is accompanied by an increase in draft. Contrary to popular belief, only a small part of the increased draft is due to acceleration of the soil particles. The other factors are as yet unknown.

Why a soil bin is used

Laboratory models are being used in an indoor soil bin because field studies of the soil-cutting process are complicated by the variability of the soil. Variations in moisture content, cover, soil type, and previous history can cause large differences in soil strength within a relatively short distance in the field. Other variables, such as changes in speed and depth of cut, may be introduced by the operator. Thus, in field studies, it is difficult to tell whether a change in force is due to the uncontrollable variables or to a change in implement design.

Even in an indoor bin, changing moisture content can cause so much variation in the properties of a natural soil that accurate testing is impossible. Therefore, an artificial soil, consisting of a clay mineral and oil, is used. The properties of this soil can be held constant so that tests may be conducted over a reasonable length of time without the variable of soil strength affecting the results.



Overall view of soil bin with rototiller.

The soil bin is 30 inches wide, 8 inches deep, and 33 feet long. The soil is automatically reconditioned with a rototiller followed by a steel roller. Speed of travel can be preset, and forces on the tool are measured by a strain gauge transducer. Properties of the artificial soil can be controlled within limits by varying the number of roller passes and the weight of the roller.

How soil failure is observed

The tools used for cutting the soil are flat steel plates, 3 inches wide and 2 inches deep, inclined at 90°, 60°, 30°, and 15° to the horizontal. Before a test, the soil is cut away to a vertical plane through which the edge of the tool will pass, and a chalk grid is placed on the vertical soil surface.

High-speed movies are taken of the soil failure and of the changes in the chalk grid as the tools move through the soil at speeds of 0.5 to 2.5 miles per hour. Simultaneously a direct-writing oscillograph records all the forces imparted to the tool by the soil. The oscillographic trace is correlated with the movie film by means of a 60-cycle-per-second timing mark which appears on both the film and the oscillographic trace. In addition, an oscilloscopic trace of the horizontal force is superimposed on the movie film. Study of the films and the force recordings will give a better understanding of the soil-cutting process.

More complicated studies

In future projects, tools with more complicated shapes will be tested in the soil bin, and tire-soil relationships will be studied. Eventually it should be possible to design tillage and earthmoving equipment on the basis of the laboratory studies, then test them in model form in a soil bin — much as aircraft are designed and then tested as models in a wind tunnel.

David J. Olson is an Assistant in Agricultural Engineering. This paper is based on work that he did for his M.S. degree.

EXTENSION'S GOLDEN ANNIVERSARY

J. B. CLAAR

THIS YEAR marks the fiftieth anniversary of the Cooperative Extension Service. It's a good time to recall past achievements and discuss some trends of the future.

The Cooperative Extension Service has been termed one of the most frequently copied innovations of the United States. During the last decade a great many countries have been busily engaged in building their own version of an Extension Service. In fact, Nikita Khrushchev, having noted the achievements of the county agents in the United States, recently stated that the Soviet Union should develop such an organization.

Turner saw need

As a brief historical note, it should be remembered that more than a hundred years ago Jonathan Baldwin Turner, a professor at Illinois College in Jacksonville, called for a program of practical adult education.

While campaigning for the development of a Land-Grant College system, he said, "The world has never developed any efficient system for getting the practical information applied that does exist." Another statement was, "The world has long since decided that its teachers must be educated, but it has not yet recognized that its workers need education just as much."

Turner's ideas were fulfilled with the establishment of the Land-Grant College system and the emergence of the Cooperative Extension Service. When the Extension Service was first established, people scoffed at the new Extension agents, but the organization survived the test of time to receive widespread acclaim for its accomplishments. In fact, C. Hartley Gratton, in his book *In Quest of Knowledge*, recognizes the Cooperative Extension Service as the largest and most successful adult education venture in America.

Our present assets

Evidence of Extension's contribution in Illinois exists in every community of the state, no matter how far removed from the county seat or the main road. This evidence is found in well-informed adults and youth who, through informal education, are highly competent to manage their businesses and homes and to be leaders in their areas.

Today as we look to the future the Extension Service in Illinois counts among its assets the following:

- **Experience in the use of informal education methods** which include techniques not just for imparting knowledge but also for encouraging the application of information.
- **A field staff** in each county and at the University that is more highly trained than at any previous time in history.
- **Access to reservoirs of knowledge** at the University of Illinois.
- **Support from and liaison with agencies** at the federal, state, and local levels.
- **A process of local program development** which maintains flexibility and gives priority to pressing local problems.
- **On-going programs** that are enjoying excellent reception. More people are using the county offices than ever before. At the same time a more systematic job of education is being done.

Future trends

Even with these assets, the future poses difficult problems of priority to Extension. Our audience is now much more varied than in the past. These are some of the programs necessary to meet the demands being placed upon Extension:

- **A top job with commercial producers,** including emphasis on buying and selling problems.
- **A strong program in management** and decision-making, especially for younger families. This includes the use of tools for business analysis.
- **A resource development** program to help communities work toward economic growth and civic improvement.
- **Expanded programs in public affairs** to help farmers understand the economic climate in which they operate and the issues which affect them.
- **A program in family living** that deals with significant concerns. Such a program will adapt family-living and home-economics subject matter to the needs of families at various economic and social levels.
- **Continued strong emphasis on 4-H** and other Extension youth programs that emphasize both "learning by doing" projects and the development of skills and knowledge necessary to cope with modern problems in living and earning a living.
- **An effective program with agriculture** beyond the farm, including both the service and the marketing industries.

The Cooperative Extension Service remains dedicated to the goal of giving the people of the state the benefit of the knowledge which the University has to offer in agriculture, home economics, and related subjects. Although Extension programs have changed greatly during the last 50 years, staff members continue to exhibit the same dedication for service that characterized the first Extension workers and the same passion for finding critical problems as targets for educational programs. Proud of our past, we work in the present and plan for our future.

J. B. Claar has been Associate Director of the Cooperative Extension Service since September 1, 1960.

RESEARCH IN BRIEF

Moisture Content of Plywood Paneling in Confinement Swine Buildings

In winter, when ventilation rates are held to a minimum, excess moisture tends to collect within confinement livestock buildings. Excessive moisture not only is undesirable for the animals but can also be detrimental to the structure itself.

For one thing, wood is hygroscopic (that is, it can absorb and retain water from the atmosphere). As air temperature and relative humidity fluctuate, so does the moisture content of the wood. Wood fibers expand and contract with changes in moisture content, causing variations in the dimensions of wood structural members. Another difficulty is that decay and fungi are more likely to be troublesome when moisture is excessive.

Finally, excess moisture creates problems with nails and fasteners. Joints are not as strong when connecting moist wood as when connecting dry wood, because the wood itself is actually weaker. Dimensional changes in wood, resulting from changes in moisture content, also weaken the joint.

When glue is the fastener, the effect of moisture on the glue is more important than the dimensional changes of the wood. Glued joints can be stronger than the wood itself, but moisture reacts with most glues, tending to weaken the glue bond. Urea resin, polyvinyl, resin, animal, and starch glues have high strength when dry but are not water-resistant. Casein glues have high dry strength and are also water-resistant. Resorcinal resin, phenol resin, and malamine resin glues have high wet and dry strength and thus are waterproof glues.

The effects of winter moisture on plywood paneling were studied in five confinement swine buildings at the University of Illinois. The buildings had batt insulation, a vapor barrier, plywood interior lining, concrete floors, and forced ventilation.

Average moisture content of the interior plywood paneling during the winter months was slightly over 15 percent. Individual samplings taken with an electric moisture meter ranged from 8 to 50 percent. The high readings were in locations near fans and vents or where the inside moist air was cooled upon contact with uninsulated air ducts. The highest weekly average moisture content was 18 percent and the lowest was slightly under 13 percent.

The plywood paneling was sampled to determine whether any significant differences in moisture content could be found at various heights within the building — that is, at floor, plate, and ceiling levels. In four of the five buildings, floor humidity was a few percentage points higher than ceiling humidity. In the fifth building, humidity was higher near the ceiling away from the pigs. No significant differences, however, were found in the sidewall paneling moisture content at the different levels.

This study indicates that plywood used as the interior wall lining should be the exterior type. It is, however, improbable that the moisture content of the framing lumber would ever be too high for safe use of glues such as casein, assuming adequate ventilation and the use of vapor barriers. — *Cecil Hammond and D. L. Day*

Moisture meter used to measure moisture inside swine buildings.

Effects of Rotation and Cultivation Practices on Future Farm Income

The influence of soil conservation on farm income was recently studied in the Department of Agricultural Economics.

Calculations were made for Swygert soils. These "tight" soils are in northeastern Illinois. To start with, it was assumed that only moderate erosion had occurred on these soils and that 3 inches of the A_1 horizon and 7 inches of the AB remained.

Soil losses were calculated for several rotations, each in combination with two cultivation practices — up-and-down cultivation and contouring. From these soil losses, it was possible to predict yields for each cropping system far into the future. These yields formed the basis for estimating incomes from each of the various cropping systems.

To make alternative cropping systems comparable in terms of income over a period of years, it is necessary to discount these incomes. By discounting, income in the distant future is considered to be worth less than income in the near future. The higher the discount rate, the greater the premium on income in the near future.

As an example, total net returns discounted at 5 percent on 4-percent contoured slopes were as follows:

Cropping practice	*After 25 yr.*	*After 50 yr.*	*Annual soil loss (T./A.)*
Continuous corn . .	$322	$397	9.4
C-C-SB-O-M	285	361	3.7
C-C-O-M-M	282	363	2.2

Even after 50 years, a long planning horizon for an individual farmer, total discounted returns are estimated to be higher for continuous corn than for either of the other two cropping systems. However, the A_1 horizon (assumed to be 3 inches at the start of planning) would have disappeared in about 40 years, while it is expected to disappear in about 100 years with C-C-SB-O-M, and 175 years with C-C-O-M-M. Only with the last of these cropping practices is annual soil loss less than 3 tons per acre, which is the recommended maximum.

These results suggest that a farmer on Swygert soils would sacrifice income during his lifetime by keeping soil losses at or below the recommended level. This does not mean that he would serve the best interests of society by permitting his soil losses to exceed 3 tons. But the "correct" balance between present and future needs may be calculated from the standpoint of the individual farmer as well as society. If the soil loss tolerance of 3 tons reflects the best possible estimate of future national needs, we will need to find ways of achieving this goal without undue sacrifice of income by individual farmers. — *E. R. Swanson*

A Study of Livestock and Crop Adjustments Made on Illinois Farms, 1951-1962

The object of a recent study in the Department of Agricultural Economics was to determine what farming adjustments had been made by a group of farmers who had stayed in business from 1951 until 1962.

Information was obtained from records kept by farmers enrolled in the Illinois Farm Bureau Farm Management Service. Selected financial and production factors on 198 farms in the 1951-1953 period were compared with the same factors on the same farms in 1960-1962. Although the trends noted on these farms may reflect the changes on commercial cornbelt farms in Illinois, there is no assurance that the information obtained from these records is directly representative of all farms.

Of the 198 farms studied, 143 were in northern Illinois and 55 in southern Illinois. In 1951 the type of farming was about equally divided among dairy, cattle-hog, and grain.

Between 1951-53 and 1960-62, average acres per farm increased by about 15 percent in northern Illinois, and by 12 percent in southern Illinois. Farms became more specialized, with greater emphasis on the high cash-value crops, corn and soybeans. The number of large livestock enterprises (more than 20 dairy cows, 60 beef cattle, 60 litters of hogs, or 750 hens) increased, while the number of smaller enterprises tended to decrease.

Even though size of farm and size of livestock enterprises increased, the average months of labor per farm changed very little. The combined effect of increased size of business and of automation on these farms has greatly increased output per man. When measured in constant dollars (1957-1959 = 100), output per man increased by 60 percent in northern Illinois, and nearly doubled in southern Illinois. These changes are indicative of the brain power needed in relation to muscle power for managing farms in the future. — *D. F. Wilken*

Sheep Utilize Elemental Sulfur and Sodium Sulfate to Produce Wool Proteins

Keratins are the typical protein found in horns, hooves, feathers, hair, wool, and similar substances. Since keratins contain relatively large amounts of sulfur, research workers in nutrition have wondered to what degree, if at all, the ruminant can utilize sulfur in forms other than preformed proteins.

Research workers in South Africa studied this problem intensively during the 1930s. They separated locks of wool into parts representing growth at different times of year, and found that these parts apparently varied in percent of sulfur. When inorganic forms of sulfur were added to diets which were thought to be rather low-quality, growth responses were sometimes favorable, other times not. After several years of such study, results were too variable to conclude that inorganic sulfur was being incorporated into the proteins utilized by sheep.

Because of the relatively large variety of radioactive isotopes available after World War II, it seemed obvious that appropriate ones should be used to trace biochemical reactions and processes. Sheep, with relatively high production of keratin in wool, appeared to be an ideal experimental animal to test the metabolism of sulfur, using isotopes as tracers.

Such experiments were initiated at Illinois, involving sulfur^{35} both as elemental sulfur and in sodium sulfate. It was clearly demonstrated that sheep used both forms to produce blood proteins and wool proteins. The sulfate sulfur seemed to be utilized more efficiently than the elemental sulfur, which has been confirmed in more recent research.

This research demonstrated rather dramatically the increased precision of techniques using radioisotopes. The ultimate significance of this research is that it will provide information for formulating more precise and efficient diets for ruminants. — *U. S. Garrigus and E. E. Hatfield*

COMING EVENTS

(A partial list of meetings scheduled at Urbana)

Oct. 17-31: Town and Country Art Show

Oct. 28-30: Farm Management Fieldmen's State Conference

Nov. 6-7: Illinois Home Economics Association Meeting

Nov. 19: Farm Structures Day

Dec. 2-4: Rural Sociology Seminar

Dec. 3-4: Fifth Annual Turfgrass Conference

Dec. 11: Sheep Day

FARM BUSINESS TRENDS

The 1964 growing season was marked by serious drouth over large areas of the nation, as shown by the maps below. The map on the left shows feed crop prospects on September 1 while the one on the right shows pasture feed conditions the same date.

The early part of the growing season was favorable over practically all of Illinois. But by July 1 the eastern half of central Illinois was short of soil moisture, and a more serious drouth was pushing into the southern tip of the state.

By August 1 most of the southern half of the state was dry to very dry, while the northern half was in good to excellent condition. August brought very little rain to the state, except in a narrow belt across the northern part from Lake Michigan to Rock Island.

Temperatures ran unusually high in the southern half of the state just as corn was tasseling and soybeans were blooming. Most of the area suffered from severe to extreme drouth during August and the first half of September. Corn and soybeans were generally poor, but ranged from practical failure to good.

The northern half of the state escaped the excessive heat at tasseling and blooming times, but soil moisture became short almost everywhere, except in the narrow belt noted above. The shortage of moisture cut yields in some places; however, yields were generally good throughout that part of the state.

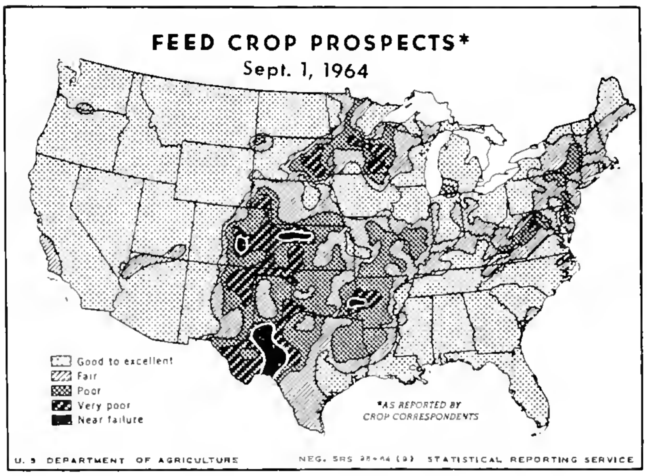
General rains came during the third week of September. They arrived too late to help most of the corn and soybeans, but aided late pastures and provided essential moisture for plowing and fall-seeded wheat.

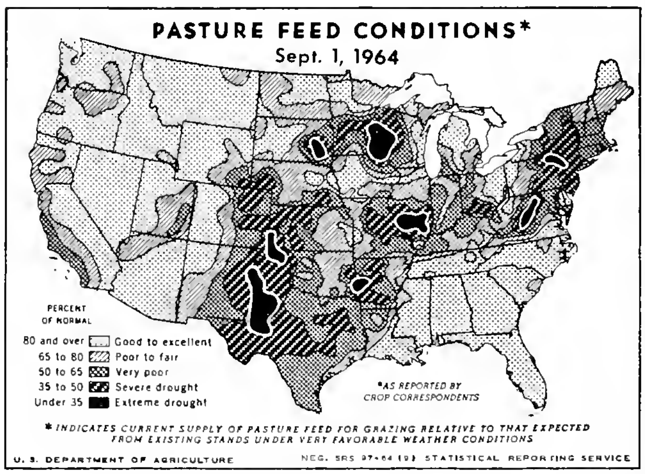
Others areas suffering from drouth and excessive heat are shown by the shaded areas of the maps. Most of the vast region from the Mississippi River to the Rocky Mountains was especially hard hit. Another large drouth area covered most of the eastern states.

It is important to note that most of the central cornbelt escaped the worst of the drouth. Thus crops are good over most of Iowa, the northern half of Illinois, southern and eastern Wisconsin, and most of Indiana, Ohio, and Michigan. The southern states had some drouthy areas during the early summer, but had ample rains later. The western states also had average and better growing seasons.

Supplies of roughage are generally short in the drouth areas. Prices of feed — both roughage and grain — will be higher than usual in comparison with prices in other areas.

There will be some liquidation of cattle in the drouth areas, but numbers may be increased in the south and west. Hog production may be cut on the borders of the cornbelt — especially in Missouri, Minnesota and southern Illinois. — *L. H. Simerl*





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Winter, 1965

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Stunted plants and nubbin ears are two symptoms of maize dwarf mosaic which first appeared in Illinois cornfields last summer (page [illegible])

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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Louis B. Howard . . . . Dean and Director

M. B. Russell . . . . Associate Director

Adrian Janes . . . . Station Editor

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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NEWS AND VIEWS

Experiment station building in Sierra Leone.

In other lands. In this era of "rising expectations," many of the new nations are seeking help in their efforts to break out of the backwater of cultural stagnation into the mainstream of economic and social advancement. Dr. Kastelic of the Department of Animal Science and Dr. E. R. Leng of Agronomy have recently accepted 2-year assignments in Sierra Leone and India, respectively, where they will help to establish programs of agricultural research designed to assist those nations in their efforts to improve agriculture and rural welfare. It is anticipated that other staff members will become involved in short-term work on specific projects in these and other foreign countries as our agricultural research programs become increasingly international in scope.

Working together. As our society advances and becomes more complex, there is an increase in the interdependence among its many component parts. This is particularly true in agriculture. Few of the problems being investigated by agricultural scientists are unique to a given state or to a single scientific discipline, and the solution of such problems would be greatly delayed if each investigator worked in intellectual isolation. The cross-flow of ideas, new techniques, and concepts among experiment station scientists and their contemporaries in other states, in Federal research units, and in industrial laboratories is encouraged through work-planning conferences at the state, regional, and national levels and by frequent informal exchanges between individual scientists. In this way, duplication of effort is minimized and full and rapid use of new knowledge is achieved. — *M. B. Russell*

MAIZE DWARF MOSAIC poses a potential threat to the Illinois corn crop

When maize dwarf mosaic first attacked corn fields in southern Illinois, it was thought to be corn stunt, but it is now known to be a different disease

H. H. THORNBERRY and M. C. SHURTLEFF

In 1962 a new disease was reported in Ohio and Arkansas corn fields. By 1964 it had spread through many parts of these states and had also appeared in at least eleven other states, including Illinois.

Some 2,000 acres were infected in southern Illinois, about half of this acreage being in Pulaski and Alexander counties. The disease was also found in Massac, Union, Jackson, Calhoun, and Wabash counties. It was suspected in Champaign, Coles, Macon, and Vermilion counties but was not positively identified.

The corn crop was reduced by 70 percent or more on about 400 acres in extreme southern Illinois. On another 400 acres the loss was between 5 and 50 percent. Only very light infections were found on the other 1,200 acres.

Although the economic loss in Illinois was relatively light last year, we need only look at Ohio to recognize the potential threat of the disease. There the yield loss in 1964 was estimated at 5 million bushels. Other hard hit states were Tennessee, Kentucky, Arkansas, and Missouri. Some fields in these states have had to be taken out of corn production.

Usually the disease has been restricted to bottomland soils close to major rivers or other bodies of water. In Ohio, Tennessee, Kentucky, Indiana, Arkansas, and Missouri, however, the disease was also found in upland soils many miles from a major river.

A case of mistaken identity

When first discovered, the disease was thought to be corn stunt, a serious disease of corn in the southern states. Although closely resembling corn stunt, the new disease is now known to contain a different virus. The disease has recently been given the standard international name of "maize dwarf mosaic."

The two diseases are primarily distinguished by the ways in which the viruses are transmitted. The virus causing corn stunt is transmitted only by specific leafhoppers; the virus associated with maize dwarf mosaic is transmitted by aphids and by sap transfer.

Scientists meet

That maize dwarf mosaic is a separate disease from corn stunt was confirmed by more than 100 scientists who met at Wooster, Ohio, in late November. Concerned about further spread of the disease, the scientists had come from 32 states and Canada to pool their knowledge and discuss possible control measures.

Details of the many reports at the conference will be forthcoming in various publications. The rest of this article will be devoted to describing the disease, reporting the research that has been done on maize dwarf mosaic in Illinois, and discussing plans for future research.

Symptoms

The first symptoms of maize dwarf mosaic appear on the younger leaves as an indistinct interveinal mottling or as elongate pale green blotches (flecks) and interrupted stripes. The blotches and stripes often merge and become quite yellow (chlorotic), giving diseased plants a definite yellowish cast.

Affected plants are often quite stunted because of a shortening of the upper internodes. The degree of stunting and of later symptoms apparently depends on a number of

Mosaic mottling experimentally induced on sorghum leaves. (Fig. 1)

Corn plants infected early in the season produce only nubbin ears. (Fig. 2)

H. H. Thornberry is Professor of Plant Pathology and M. C. Shurtleff is Professor of Plant Pathology Extension. The authors are grateful to E. R. Leng, W. D. Pardee, and R. J. Lambert, Department of Agronomy, for collecting specimens of diseased corn in southern Illinois and getting the refrigerated samples to the laboratory. Acknowledgment is also made to Mary Ruth (Phillippe) Thompson for the electron microscopic examinations.

factors, including the age and maturity of the plant when first inoculated, strain of corn, strain of virus involved, environment (especially temperature), and soil fertility.

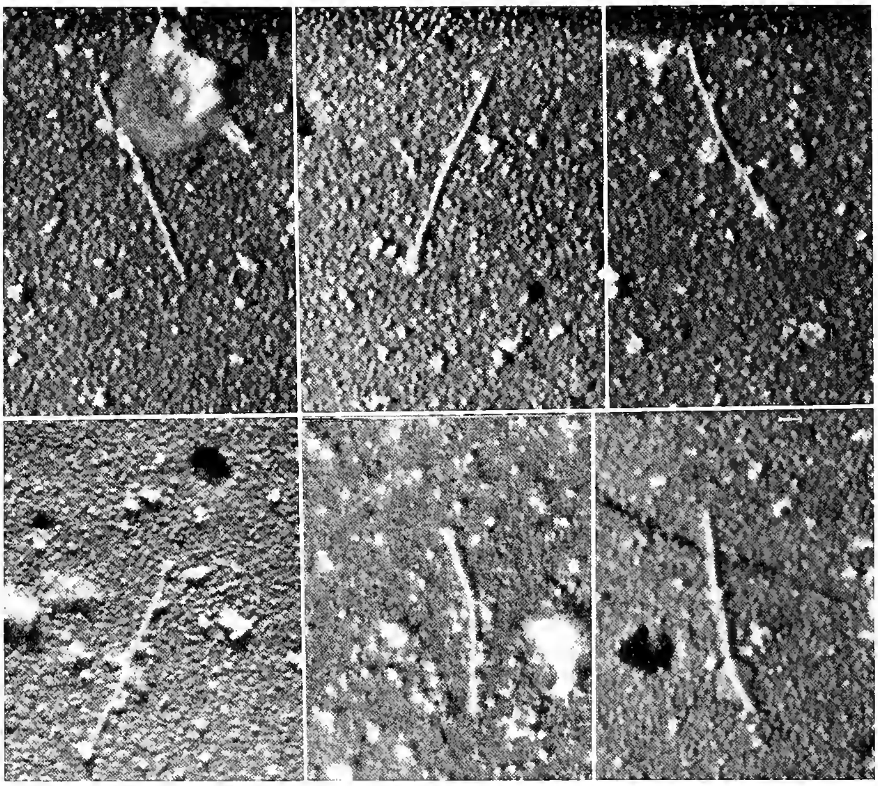
In the field, the mosaic symptoms frequently disappear, especially during the hot weather of July and August. Affected plants, however, remain stunted or dwarfed with yellowish, bunchy tops that may resemble "feather dusters."

About tasseling time, or shortly thereafter, brilliant reddish-purple streaks and blotches begin to develop in the leaves, particularly the upper ones, of many corn hybrids. Certain leaves appear largely reddish-purple. Some corn hybrids do not develop this easily recognized symptom. In some fields one can find mosaic, chlorosis, and reddening all at the same time — even on the same plant. Excessive tillering and the development of multiple ear shoots are other symptoms commonly found.

Plants affected early produce only nubbin ears that are usually partially or totally barren. Corn plants infected late in the season produce a normal crop and are normal in height. Reddish-purple blotches on the upper leaves are the only indication of disease.

Positive identification of maize dwarf mosaic *cannot* be made on field symptoms alone. Symptoms closely resembling those of the new disease may be produced by residual herbicides in the soil, mechanical or insect damage to the roots or stalk, lack of one or more essential nutrients, drouth combined with hot dry winds, and probably other causes.

As already mentioned, corn stunt closely resembles maize dwarf mosaic. Other viral infections also cause similar symptoms. For example, dwarfing and yellow mottling very like the symptoms of dwarf mosaic were induced in corn by inoculating it with an unidentified virus tentatively named Ampelamus virus. This virus has never been reported in corn from natural infection. However, since it persists in sandvine, which is very common in central and southern Illinois corn fields, it could become as important as dwarf mosaic if efficient means of transmission were to become available.



With the electron microscope, flexuous, virus-like rods could be seen in some of the mounts prepared from experimentally infected plants. (Fig. 3)

Because similar symptoms may have several possible causes, laboratory techniques, such as inoculations, serology, and electron microscopy, are necessary for identification of maize dwarf mosaic.

Precautions taken

For the laboratory investigations in Illinois, diseased corn was collected August 19, 1964, from fields in Alexander county. The specimens were sealed in plastic bags to prevent the escape of insect vectors, then were refrigerated and flown to Urbana. There they were frozen in liquid nitrogen at about —190° C. and stored at —35° C.

All work, including transmissions to living plants in growth chambers, was in the laboratory, not the greenhouse, to safeguard against escape of virus or vectors. All infective or living materials were burned or autoclaved before being discarded.

Isolation of infectious agent

A virus was isolated from the leaves of the corn plants that had been collected in southern Illinois. Frozen diseased tissue was ground in 0.1 molar phosphate buffer (pH 7.5), 1 gram of tissue being used in 0.5 milliliter of buffer. Abrasive powder (800 mesh aluminum oxide) was added to the expressed juices. Test plants (field corn, sweet corn, and sorghum) were inoculated by stroking the leaves with a finger, cloth pad, or artist's bristle or air brush containing the inoculum and abrasive. Inoculated leaves were rinsed with a fine spray of tap water within 2 minutes after inoculation. From 6 to 12 days after inoculation, infected plants developed yellow-mottled streaks at the base of new leaves.

It was still necessary to have proof that the symptoms were induced by an infectious agent such as a virus

rather than by a noninfectious agent such as a nonmultiplying toxin. For this proof, juice from the experimentally diseased plants was inoculated to healthy plants. Again the symptoms appeared. In all, the virus was transferred four times, and symptoms appeared after each inoculation. To continue itself through the transfers, the causal agent had to be infectious, capable of increase in number.

Electron microscopy

Sap from freshly prepared leaves was examined with an electron microscope for virus-like particles. Leaves were from diseased field corn found in southern Illinois and experimentally infected field corn, sweet corn, and sorghum. The sap was mounted in a droplet of redistilled water on Formvar coated grids by the quickdip method. After drying, the grids were shadowed with an electron opaque metal for observation at 5,000 to 20,000 magnifications.

Flexuous virus-like rods about 12-15 by 750-825 millimicrons were discernible in some of the mounts prepared from experimentally infected test plants (Fig. 3). Such particles were not seen in mounts of juice from healthy plants. Thus the virus-like particles in infective juice appear to be the infectious agent — a virus.

Spherical virus-like particles were also present in some mounts of juice from diseased plants but were not observed in juice from healthy plants. These observations suggest that more than one virus may be associated with the disease.

Virus purification

Attempts to purify the virus from infective juice by ammonium sulfate precipitation, low and high speed centrifugation, sucrose gradient sedimentation, and agar-gel filtration were unsuccessful. Electron-microscopic mounts of some of the preparations contained flexuous rods similar to those in Figure 3, and also spherical virus-like particles. Infectivity assays of the preparations were negative, however, indicating no infectious virus. The virus is very unstable in expressed juice.

These assays were inadequate because they were made on too few plants. It was necessary to limit the assays to the number of plants that could be grown in a 9-square-foot growth chamber in the laboratory — the only safe space available.

Final cause not yet determined

The findings reported here provide the first positive experimental proof that the new corn disease in southern Illinois is infectious. They also indicate without any doubt that a flexuous elongate virus is associated with the disease.

It has not been proved, however, that this virus is the sole cause of the disease in the field. To finally determine the primary cause, or causes, of the field disease, the typical disease must be experimentally induced with known cultures or samples of the causal agent(s), and then the agent(s) must be isolated from the experimentally diseased plant and identified.

Probable vectors and hosts

The most efficient aphid vectors, or carriers, for transmitting the maize dwarf mosaic virus in Illinois corn fields will probably prove to be those that migrate considerable distances and move restlessly about from plant to plant within a field. They may not necessarily be those that find corn a suitable host on which to feed regularly and multiply.

Johnsongrass, which is prevalent along the river valleys where maize dwarf mosaic is most serious, is probably the most important overwintering host of the virus in Illinois. Several aphid species also feed on Johnsongrass from early spring until late fall.

Control measures

At present the development of resistant corn varieties appears to offer the best lasting means of control. No corn breeder can say how long it will be before commercially acceptable, resistant single and double cross hybrids will be available. Workers are optimistic, however, that suitable replacements for the more susceptible commercial lines can be developed.

Until resistant varieties become available, the most immediately effective control measure is to eradicate Johnsongrass. Other perennials and winter annuals known to serve as virus reservoirs and thus as primary sources of virus inoculum, should also be controlled.

Investigations for 1965

Various specialists on the University campus and elsewhere in the state are cooperating to learn more about maize dwarf mosaic and to develop possible control methods.

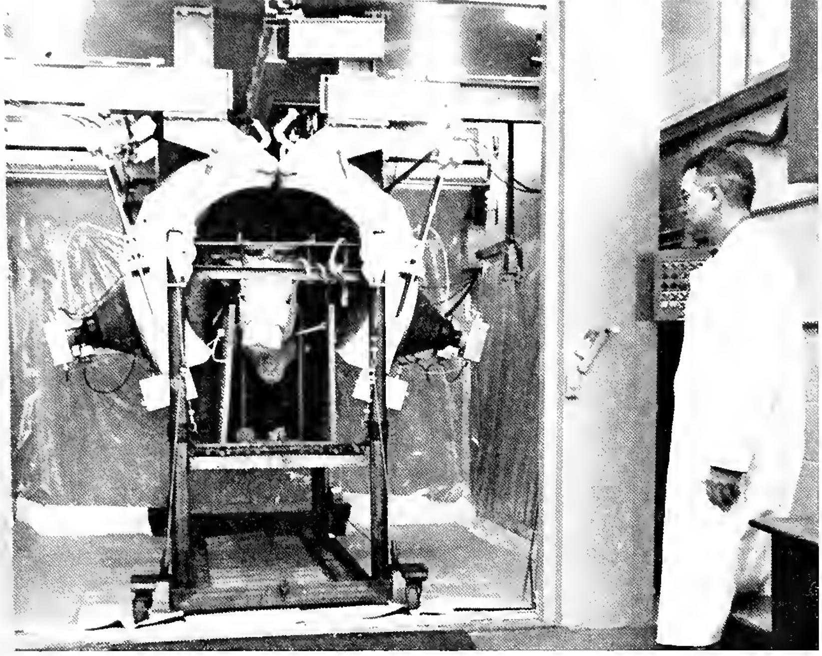
Plants will be assessed for their insusceptibility, susceptibility, resistance, and tolerance to natural viral infections in the field. They will also be experimentally inoculated in infested areas and in greenhouses under controlled conditions. Hybrids, varieties, and germ plasm of corn (field, sweet, and popcorn) and sorghums will be included.

A survey will be conducted throughout the state to determine the distribution of virus in corn and other known host plants. A vigorous campaign will be waged to eradicate Johnsongrass and other perennials or winter annuals harboring the virus in the vicinity of corn.

Vectors that spread the disease will be studied. Their movement, spread, and regeneration will be assessed in relation to flight distance, time of year, and the stage of development of corn and virus-reservoir plants.

Efforts to purify and characterize the virus and to determine its host range will continue. With purification of the virus, it will be possible to identify different strains, develop serological techniques for quick and reliable diagnosis of the disease, and develop control measures.

Finally, the search will go on for the full cause of the disease — whether it is the maize dwarf mosaic virus alone or whether it is a complex of two or more infectious agents.



Illasco can measure radiation from a full-grown beef animal. Shown in the picture is O. Burr Ross, former head of the Animal Science Department, who was instrumental in acquiring the instrument.

An Animal's Natural Radioactivity Is a Measure of MEATINESS

G. S. SMITH, T. G. LOHMAN, A. R. TWARDOCK, and B. C. BREIDENSTEIN

A NEW INSTRUMENT at the University of Illinois is being used to determine whether an animal's natural radioactivity is an accurate measure of its meatiness. The instrument is known as Illasco (Illinois Animal Science Counter). Custom built by a commercial concern, it can measure gamma radiation from samples as large as a full-grown cow.

Traditionally, the only valid way to measure lean meat has required the slaughter of the animal and the laborious task of dissecting the carcass into lean, fat, and bone. There has thus been an obvious need for precise, objective measurements of meatiness in a live animal.

Illasco permits us to use a scientific discovery made several years ago. This discovery was that naturally occurring nonradioactive potassium-39 contains a small but measurable and constant amount of radioactive potassium-40 (K-40). The gamma ray emitted from K-40, like an X-ray, penetrates through tissues and even through thin sheets of metal. Since the amount of K-40 is constant in all natural sources of potassium, a measure of gamma radiation from K-40 is, in fact, a measure of potassium.

An essential constituent of animal body, potassium is found mostly in the lean tissues. Considerable evidence indicates that, within species, the potassium content of fat-free, dry tissue is quite constant among healthy animals. Theoretically, then, one should be able to estimate lean tissue in the animal simply by measuring the *gamma* radioactivity from K-40 in the body, calculating from the K-40 the total potassium in the body, and then calculating the amount of lean tissue in which the potassium is contained.

In practice, the measurement of K-40 in the intact animal or even in the carcass presents many difficulties, the chief one being the size and cost of a gamma-ray counter big enough to accommodate farm animals. A few instruments that can accommodate pigs, sheep, and humans have been built by other institutions in recent years, but Illasco is the only instrument of its kind large enough to accommodate cattle.

Nature of Illasco

Illasco consists of two large tanks filled with about 500 gallons of organic solvent containing chemical "scintillators" in solution. These chemicals (diphenyloxazole and paraphenylene phenyloxazole) absorb the energy of gamma rays and emit light.

The tanks comprise the "windows" of Illasco. They are curved and are mounted on tracks for mobility. The result is a wide flexibility in the size and nature of samples that can be partially enclosed between the tanks and "counted" by the instrument. A 50-ton vault with steel walls 5 inches thick surrounds the tanks, shielding the highly sensitive equipment from cosmic and environmental radiation. This increases the instrument's sensitivity to radiation from the samples, so that accurate counts of K-40 are obtained within 4 to 8 minutes.

Twelve highly sensitive photomultiplier tubes are focused into the tanks. These tubes are capable of detecting the microscopic flashes of light emitted by the scintillators within the tanks. Light flashes "seen" by the tubes initiate electrical impulses which are multiplied in the tubes thousands of times and are relayed as electrical "pulses" or counts to electronic equipment capable of recording thousands of such pulses or counts per second.

Impulses from the tanks and tubes are directed through a 400-channel pulse analyzer by which radioactivity of various energies and thus the sources of the radioactivity can be identified. In the routine studies involving whole-body counting of ani-

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G. S. Smith is Assistant Professor; T. G. Lohman, Assistant; B. C. Breidenstein, Associate Professor, all in Animal Science. A. R. Twardock is Assistant Professor, College of Veterinary Medicine.

mals, only the impulses associated with the regions for cesium-137 and for K-40 are counted separately on two single-channel analyzers.

Will Illasco measure meat?

There is little doubt that Illasco can measure K-40 with precision. The factor which decides whether it can be used to measure meat is animal variation. External contamination and the amount and radioactivity of gastrointestinal "fill" are the sources of animal variation most likely to preclude the usefulness of the technique. Cattle and sheep, in particular, vary widely in amount of gastrointestinal fill.

For two years we have been conducting an intensive research program to determine whether the relationships between animal radioactivity and carcass meatiness are constant enough to allow prediction of body lean tissue from the count of whole-body radiation.

The research involves these steps: (1) Counting the radioactivity of the live animal. (2) Slaughtering the animal and recounting the carcass and all the various non-carcass components of the body. (3) Dissection of the carcass into lean, fat, and bone, and weighing each. (4) Recounting separately the lean, fat, and bone. (5) Analyzing the carcass lean for extractable fat, moisture, and potassium.

Results thus far

According to data from the first year's studies, live weight alone accounted for 86.7 percent of the total variation in fat-free lean tissue (FFLT) in 46 steers ranging from 650 to 1,200 pounds. Live body count accounted for 42.5 percent of the total variation. Together, live weight and live count accounted for 90.6 percent of the total variation in FFLT, and permitted FFLT to be estimated with a standard error of ±5.6 percent (that is, 5.6 pounds for every 100 pounds of FFLT). A summary of data from these 46 steers is given in Table 1.

Table 1 — Relationships Between Live Animal Weight, Live Animal Gamma-Activity, and Fat-Free Lean Tissue (FFLT) of Carcass

Variable	Mean	Standard deviation	Coefficient of variation	R^2 or r^2	Standard error of estimate: Pounds	Standard error of estimate: Percent
First year, 46 steers in study						
FFLT, lb.	293.6	53.9	18.4	...	...	...
Live weight, lb.	903.0	192.8	21.3	86.7	19.7	6.7
Live count	211.5	21.4	10.1	42.5	41.0	13.9
Live weight and live count	..	..	....	90.6	16.5	5.6
Second year, 21 steers in study						
FFLT, lb.	236.7	32.1	13.5	....	....	...
Live weight, lb.	734.5	88.7	12.1	78.0	15.1	6.4
Estimated gm. of K from live count[a]	713.4	93.9	13.2	87.6	11.6	4.9
Live weight and gm. of K			..	94.3	8.2	3.5

[a] Efficiencies estimated from phantom calibration curve.

By mid-July of 1964, the second year of counter operation, 21 steers had been studied under conditions which included these modifications of the first year's procedures: (1) The diet was standardized for one week before the live body count. (2) The efficiency with which the counter counted large samples was accurately measured, using a large phantom as the standard source. (3) Studies of background depression and of changes in instrument efficiency with changes in sample size were used to develop a mathematical formula that permits an indirect estimation of the body potassium from the live count.

The data from the 21 steers (Table 1) indicate that the standardized procedure for handling animals and the refinements in calibration procedures markedly improved the precision of estimating FFLT. When estimated grams of potassium, on the basis of body count, was the independent variable, FFLT was predicted with a standard error of ±4.9 percent. Body weight alone predicted FFLT with a standard error of ±6.4 percent. When both variables were used, the error of prediction was lowered to ±3.5 percent.

During the first year, 52 steers of four different breeds were studied to see how well FFLT could be predicted within narrow ranges of weight at various stages of growth. Steers were slaughtered at weights in the ranges of 650-700, 800-850, 975-1,025, and 1,150-1,200 pounds. The accuracy of the predictions from carcass weight and carcass count is shown in Table 2. The standard error for the entire group was ±3.6 percent.

Table 2 — Fat-Free Lean Tissue (FFLT) As Predicted by Carcass Count in Four Weight Ranges

Weight range, pounds	Pounds of FFLT: Mean	Pounds of FFLT: Standard deviation	Standard error
650–700	226.36	±15.61	±4.0
800–850	282.81	±18.99	±3.9
975–1,025	326.58	±14.30	±2.1
1,150–1,200	348.47	±33.00	±3.5

Detailed studies have also been conducted with sheep, but the data have not yet been completely analyzed. It is anticipated that meatiness in sheep can be estimated from weight and radioactivity data about as precisely as in cattle.

Results to date demonstrate that animal and instrument variations can be suitably minimized and that Illasco provides a highly efficient and rapid means of estimating body lean tissue in either the carcass or the living animal. In a sense, Illasco allows the scientist to "slaughter" the same animal over and over to study changes in the body lean tissue.

Whole body counters will undoubtedly become the means whereby various nutritional, physiological, genetic, and pathological factors may be studied for their effects on body lean tissue as well as animal weight and performance.

WOOD SLOTTED FLOORS

Tried for Raising Hogs

W. F. NICKELSON, J. O. CURTIS, and C. S. WALTERS

SWINE PRODUCERS continue to like the idea of slotted floors for raising hogs in confinement, mainly because labor is saved in handling manure.

Although research has answered many questions about the successful use of slotted floors, further questions still need to be resolved. Some of them concern the search for materials that are more economical than those now commonly used and are also satisfactory in performance and length of service.

Recently a study of wood slotted floors was initiated by the Departments of Agricultural Engineering, Forestry, and Animal Science, in cooperation with the U.S. Forest Service. The variables tested were: (1) two species of wood slats — Douglas fir and hickory; (2) two widths of slat — 2 and 4 inches; (3) three slot widths — ½, ¾, and 1 inch; and (4) two methods of chemical treatment versus no treatment. Some slats were pressure-treated with pentachlorophenol ("penta"), some were cold-soaked 48 hours, and some were left untreated.

Slats were beveled on one edge so that the bottom was ½ inch narrower than the top. The floor sections were installed in two buildings on the Moorman Research Farm. One building served as a nursery unit, housing pigs 3 to 8 weeks of age, while the other building served as a growing-finishing unit for pigs from 40 pounds to market weight.

In both units the experimental slats were installed over 3- or 4-foot wide pits located at one end of the pens. Pen width varied but pen length was 10 feet in the nursery unit and 16 feet in the growing-finishing unit.

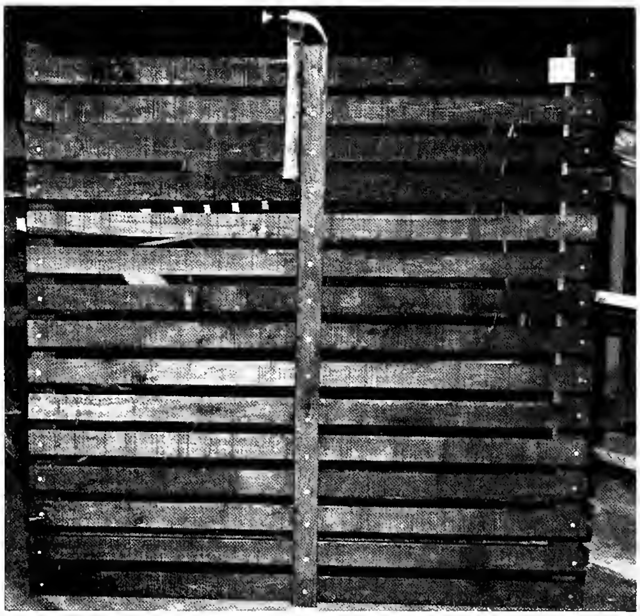
Growing-finishing unit

Although the study has not been in progress long, some conclusions can already be drawn concerning the floors in the growing-finishing unit.

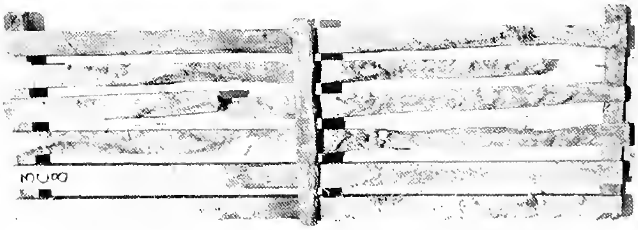
Douglas fir slats did not appear satisfactory for hogs weighing 70 pounds or more. Pigs of this size quickly chewed through a number of slats, extensively damaging the floors. One group chewed through a 2-inch slat in just a few hours. Treatment with pentachlorophenol did not protect the Douglas fir slats from chewing.

So far the hickory slats show little or no evidence of wear or animal damage.

Slats ½ inch apart were too close for "self-cleaning." A considerable buildup of manure occurred, regardless of slat width. Each pig was provided 4 square feet of floor space; therefore, poor cleaning did not result from a lack of "traffic." Slats spaced ¾ inch and 1 inch apart had about the same degree of cleaning efficiency with both slat widths tested.



A section of 2-inch hickory slats with ¾-inch spacing, before it was used. Pigs did very little damage to hickory floors.



Douglas fir slats did not hold up against the chewing of growing-finishing pigs.

There has been no evidence of animal discomfort due to slat width, slot opening, or chemical treatment.

Nursery unit

These observations were made in the nursery unit, where pigs weighed 15 to 40 pounds:

Damage to slats, even those of Douglas fir, has not been measurable. Pigs under 40 pounds apparently do not cause the damage that heavier pigs do.

Again the slats spaced ½ inch apart did not clean nearly as well as those with a ¾-inch or 1-inch spacing.

The pigs have apparently not been harmed by the chemical treatment or any of the other variables tested.

Further studies

Tests are being continued with the nursery and growing-finishing units, and plans are being made to include farrowing quarters in the studies. Results will be reported as they become available.

W. F. Nickelson is Visiting Associate Professor of Animal Science; J. O. Curtis, Associate Professor of Agricultural Engineering; C. S. Walters, Professor of Wood Technology and Utilization.

Economic Importance of Wood-Using Industries

Although Illinois industries make heavy use of wood, the state has not realized its potential for wood production

I. I. HOLLAND

WOOD as a raw material makes a much greater contribution to Illinois's economy than is perhaps commonly realized. In fact, Illinois is one of the major wood-using states in the country.

The most important single use of wood in Illinois is for residential and nonresidential construction. Softwood lumber is preferred for this purpose because it is available in large sizes and quantities and because it is cheaper and more easily worked than hardwood lumber.

Value of timber-based activities

In the nation as a whole, activities directly related to timber or wood use were valued at approximately 25 billion dollars in 1958 (Table 1). This amount represented 5.6 percent of the gross national product. Viewed another way, about one dollar in every 18 originated in some kind of timber-based economic activity.

The value of timber increased about 25 times between the stump and delivery of finished products to ultimate consumers. In 1958 harvesting added about $1.50 to every $1.00 of stumpage (standing timber) cut; primary manufacturing, $3.85; secondary manufacturing, $5.45; construction, $7.60; and transportation and marketing, $5.35.

Looking at Illinois (Table 1), we see that the value of timber-based activities was about 1.4 billion dollars in 1958, some 5.5 percent of the U.S. total. Only New York (9.8 percent), California (9.1 percent), and Pennsylvania (slightly over 5.5 percent) were more important than Illinois.

I. I. Holland is Professor of Forest Economics, Forestry Department.

Employment

Timber-based activities provided work for about 3.3 million people in this country in 1958 (Table 2). These people represented more than 5 percent of the total civilian labor force in the United States; in other words, one person out of every 20 employed was engaged in some kind of timber-based activity.

Of the people employed in this way, only 3 percent were engaged in timber management. Another 10 percent were employed in harvesting; 15 percent in primary manufacturing; 24 percent in secondary manufacturing; 25 percent in construction; and 23 percent in transportation and marketing.

In Illinois more than 156,000 persons were employed in timber-based activities in 1958. By comparison, 220,000 were employed in farming that same year.

Most wood shipped in

Of the people engaged in timber-based activities, 95 percent were employed in secondary manufacture, construction, transportation, and marketing. These activities all add significantly to the state's gross product and employment. Stumpage

(concluded on page 10)

Table 1 — Estimated Value Added to Gross Product by Timber-Based Activities in Illinois and the United States, 1958[a]

Timber activity	Value added: U.S.	Value added: Illinois	Pct. Ill. is of U.S. total
	thousands of dollars		
Stumpage cut	998,250	5,050	0.5
Timber harvesting	1,508,700	8,500	0.6
Primary manufacturing	3,855,800	48,100	1.5
Secondary manufacturing	5,446,300	327,800	6.0
Construction	7,610,000	563,200	7.4
Transportation and marketing	5,336,000	416,000	7.8
All timber-based activities	24,755,050	1,368,650	5.5

[a] Value added is the difference between cost of goods and materials purchased by an enterprise and the value of products sold. It is the amount available for payment of wages, salaries, interest, profits, property taxes, excise taxes, sales taxes, depreciation, and depletion.

Table 2 — Estimated Number of People Engaged in Timber-Based Activities in Illinois and the United States, 1958[a]

Timber activity	Number employed: U.S.	Number employed: Illinois	Pct. Ill. is of U.S. total
Forest management	82,100	800	1.0
Timber harvesting	341,250	2,500	0.7
Primary manufacturing	488,900	5,100	1.0
Secondary manufacturing	793,150	42,850	5.4
Construction	840,000	50,400	6.0
Transportation and marketing	776,100	54,900	7.1
All timber-based activities	3,321,500	156,550	4.7

[a] Employment figures represent the estimated number of jobholders whose work can be attributed to the use of wood or of wood products in the particular activity designated.

AN EXPERIMENTAL WOOD FOUNDATION

DONALD H. PERCIVAL

A PRESSURE-TREATED wood foundation for a frame house is not only cheaper than a concrete block foundation, but has several other advantages as well.

The opportunity for developing a wood foundation arose as part of a remodeling project. A 24- by 28-foot frame addition was to be joined to an existing house. The nature of the building site made it possible to investigate a foundation system other than concrete or block.

A nail-glued box beam, using treated 2 x 4's and ½-inch plywood, was designed for the perimeter of the foundation. The beams were designed and tested to support 2 x 10 floor joists on 24-inch centers, plywood and stud framing, and 28-foot nail-glued roof trusses.

Site preparation

Because the addition was to join an existing building, the soil-line was lowered for aesthetic reasons. The soil was removed with a bulldozer. This would not have been necessary had the structure been a separate building. Holes 8 inches in diameter and 3 feet deep were dug at 8-foot spacings around the perimeter.

Treatment

To protect the wood from fungi and insect attack, the members were pressure-treated with pentachlorophenol dissolved in a liquid petro-

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Economic Importance of Wood-Using Industries . . .

sales, forest management, and timber harvesting, however, add very little. This is another way of saying that Illinois woodlands do not contribute greatly to either farm or industry incomes.

It is estimated conservatively that Illinois wood-using industries consume 2 to 3 billion board feet of lumber each year. Yet 90 percent of this volume is imported from other states. About three-fourths of the imported wood is softwood lumber and has to be shipped in because Illinois's forest resource is made up almost entirely of hardwood timbers. However, there still appears to be a largely unexploited potential market for native hardwoods.

Altogether, Illinois has 3,938,000 acres of woodland. All but about 5 percent of it is privately owned. Farmers control about 82 percent of this forest resource, most of the holdings being smaller than 100 acres. Annual timber growth on Illinois woodland is estimated at about 135 million cubic feet, including 500 million board feet. This very large volume is badly underutilized; only 40 million cubic feet, including 110 million board feet, are cut annually.

There is no simple explanation for this imbalance between hardwood timber growth and utilization in a state which makes such heavy use of both hardwoods and softwoods. Forest management is not yet widely practiced on Illinois woodlands, and for this reason neither existing nor potential markets for wood can be well supplied. At the same time, because there are no extensive markets for the kinds of wood products which can be made from native timber as presently grown, few forest landowners are encouraged to undertake better management practices.

Large potentials

Without question the potentials for growing, processing, and marketing native timber are large. How to capitalize on these bright prospects is the question. It is probable that both the management and the marketing or utilization problems will have to be solved together. Research and study will be required.

So far a good start has been made at the University of Illinois in learning how the present primary forest products marketing system works. Also, some work is at present under way which, it is hoped, will shed light on the things that influence woodland owners in their management practices.

Just initiated is a study of the furniture industry in the North Central region, including Illinois. The study is designed to outline the industry's extent, location, problems, and use of raw materials. The furniture industry makes heavy use of hardwood lumber, veneer, hardboards, and particle boards. Illinois is not only the most important furniture and fixture manufacturing state in the North Central region, but it is also one of the most important states in the nation in this respect.

Finally, a study which examines the prospects for expanding the pulpwood market in Illinois is nearing completion. Increased markets for pulpwood would encourage many owners to upgrade their woodlands by removing the poorer quality hardwood timber; for this kind of timber is being used in increasing quantity for pulp and paper manufacture. Upgrading of the state's forest resource will in time increase the availability of higher quality lumber and other forest products for use in secondary manufacture. It is this kind of material which is at present being shipped into Illinois from western and southern producing areas.

leum gas. This is known as the "Cellon" process. The wood was treated in Orrville, Ohio, and trucked to Illinois. Gloves were worn when the freshly treated wood was handled during construction.

Construction and beam placement

The 2 x 4 flanges, stiffeners, and support legs were cut and nailed to form the framework of the perimeter beams (Fig. 1). High-carbon galvanized helically threaded nails were used. Next, pieces of plywood, 2 x 8 feet, were attached to the frame. They were nail-glued with a waterproof adhesive and 2-inch aluminum nails.

After the adhesive had cured, the beams were positioned with the support legs inserted in the perimeter holes. A 2 x 4 plate was then nailed to the top flanges of the beams and a surveyor's level was used to correct for height and level the units.

The support legs of adjacent beams were nailed together and positioned to allow for a concrete pad under the ends of the supports. Concrete was then mixed and poured into the holes and allowed to set.

Floor system

A girder was assembled, using double 2 x 10's, and was positioned on posts at the center line of the building. Metal joist hangers were nailed to each side of the girder, on 24-inch centers, to support the ends of 2 x 10 floor joists. The opposite ends of the joists were supported by the perimeter beams. The joists were nailed into position and the subfloor, an exterior type, C-C grade plywood ½ inch thick, also treated, was nailed to the joists.

Evaluation

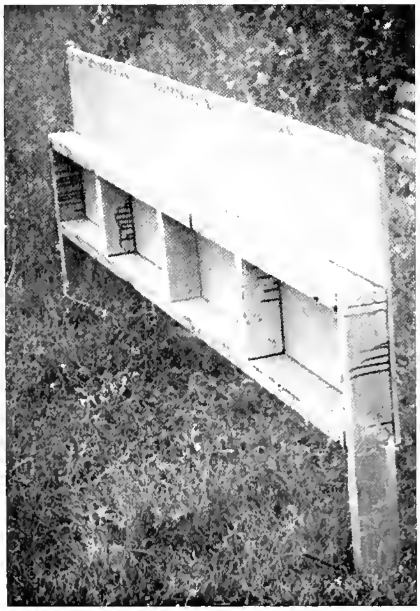
Total in-place cost for the wood foundation was $482, as compared with a cost of $627 for a theoretical concrete block foundation with wood subfloor. The treated wood foundation has these additional advantages:

It would permit construction throughout the entire year. The small area of concrete could be protected from freezing.

The prefabricated wood system is relatively lightweight and can easily be handled by two men.

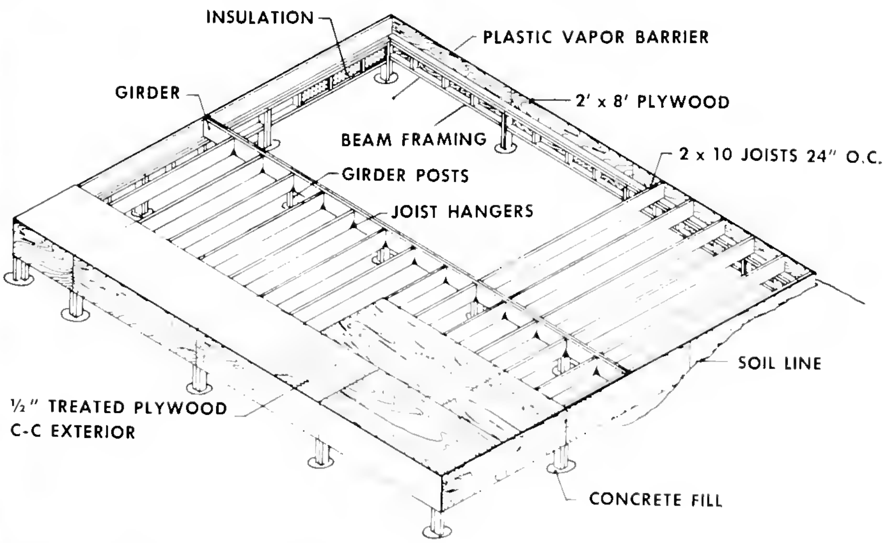
Since only a minimum of equipment and water supply is necessary, construction is simplified on remote building sites.

Donald H. Percival is Research Associate Professor of Wood Technology and Utilization, Forestry Department and Small Homes Council–Building Research Council.



An 8-foot perimeter box beam. (Fig. 1)

Beams in place to form 24- by 28-foot foundation. (Fig. 2)



The floor system used with the foundation. (Fig. 3)

Some Differences Between Rural High School Students Planning on College and Those Without College Plans

D. E. LINDSTROM

What sort of employment opportunities await rural young people who don't go to college? What sort of training do they need to prepare them for these opportunities?

Many studies have shown that rural young people are at a disadvantage, compared with urban youth, in getting and holding jobs. Part of the trouble lies in the rural schools. According to one report by the U.S. Department of Agriculture, "rural educational facilities and services have not shared fully in national growth: small school districts, low population density, and relatively low income have produced a quality of education which by many available standards is less adequate than that provided in urban systems."

Another difficulty is that most rural high school graduates do not choose to go on to college. Are there, then, significant differences in capability and interests between high school students planning to go to college and those not planning on college?

24 high schools in study

Capability differences were found in a recent study of 2,326 juniors and seniors in 24 rural high schools in Carroll, Mercer, Marshall, Moultrie, Calhoun, Franklin, Alexander, and Pulaski counties. The data were for the 1962-63 school year and were supplied by Dr. Thomas Hastings, director of the University of Illinois's high school testing program.

The students were divided into two general categories — those who were going to college and those who were not. Each group was further classified as to sex and as to residence (whether farm or nonfarm).

These different groups were compared for scores made on several standardized tests: abstract reasoning, verbal reasoning, the total of these two (a test of intelligence), social science reading, natural science reading, writing, and conventional and functional errors in writing.

How the groups compared

Of the 2,326 juniors and seniors in the 24 schools, 59.6 percent did not plan to go to college. This figure is probably representative of rural high schools in the state as a whole.

Among both the farm and the nonfarm groups, more girls than boys were not planning on college. In the farm group, the figures were 69 percent for girls and 57 percent for boys; in the nonfarm group the figures were 65 percent and 52 percent.

In all tests average scores were significantly better for the group planning on college than for the group not planning on college (Table 1). This held true for every classification on the basis of sex and residence — farm boys, farm girls, nonfarm boys, and nonfarm girls.

Other significant differences were found within the college-bound group and within the noncollege group, but none of these differences were as marked, statistically, as the differences between the two groups. These are the differences noted within the groups:

Verbal reasoning. In the group going to college, nonfarm girls did better than nonfarm boys.

Abstract and verbal reasoning (intelligence). Farm girls planning to go to college had significantly higher mean scores than farm boys in this category.

Social science reading. In the group planning to go to college, farm boys had significantly higher average scores than nonfarm boys. In the group not planning on college, farm girls had higher scores than farm boys. Within both groups, nonfarm girls did better than nonfarm boys.

Natural science reading. Farm boys planning on college did significantly better than nonfarm boys in this category. The natural environment in which farm boys work may have been a cause for this difference.

Writing. Among those planning on college, farm boys had significantly higher scores than nonfarm boys. Also, the girls, both farm and nonfarm, consistently outshone the boys. Seemingly, the girls' superior performance in this test follows the expected pattern.

Conventional and functional errors in writing. Again the farm and nonfarm girls did better than the boys, both among those planning on college and those not so planning.

Why the differences?

Data that might help to explain these differences were limited to only a few factors. One of these was the fathers' occupations. About 28 percent of the fathers of nonfarm boys planning on college were in professional, semi-professional, technical, and managerial occupations. These occupations accounted for only 14 percent of the fathers of nonfarm boys without college plans.

More important are differences in what the students themselves wanted to do in later life. Of the group planning on college, 80 percent of the nonfarm boys and 55 percent of the farm boys wanted to go into occupations that would be considered professional, managerial, or technical (Table 2). Only 17 percent of

D. E. Lindstrom is Professor of Rural Sociology.

Table 1 — Mean Test Scores by Students Planning on College (Group A) and Those Not Planning on College (Group B)

Test and sex and residence of student	Mean scores Group A	Group B[a]
Abstract reasoning		
Farm boys	35.6	30.7
Nonfarm boys	35.9	30.7
Farm girls	37.1	32.3
Nonfarm girls	35.7	30.9
Verbal reasoning		
Farm boys	29.1	21.6
Nonfarm boys	27.6	21.2
Farm girls	31.2	22.7
Nonfarm girls	29.1	21.9
Total, abstract and verbal reasoning		
Farm boys	64.3	52.3
Nonfarm boys	63.5	51.9
Farm girls	68.4	55.0
Nonfarm girls	64.9	52.9
Natural science reading		
Farm boys	32.6	23.9
Nonfarm boys	30.5	23.7
Farm girls	31.9	25.4
Nonfarm girls	30.4	24.3
Social science reading		
Farm boys	33.4	26.4
Nonfarm boys	31.1	26.2
Farm girls	34.8	29.6
Nonfarm girls	33.9	28.9
Writing		
Farm boys	47.1	40.2
Nonfarm boys	45.7	39.6
Farm girls	51.0	44.5
Nonfarm girls	50.7	44.2
Conventional errors in writing[b]		
Farm boys	15.0	19.4
Nonfarm boys	16.0	19.3
Farm girls	11.6	16.3
Nonfarm girls	12.6	16.9
Functional errors in writing[b]		
Farm boys	6.6	9.0
Nonfarm boys	6.8	9.2
Farm girls	4.7	7.4
Nonfarm girls	5.4	7.6

[a] All differences between Group B and Group A scores were statistically significant at the .001 level using the "t" test.
[b] Larger scores mean more errors and therefore lower achievement.

Table 2 — Occupations That Students Hoped to Enter

Occupation	Planning to go to college: Farm Boys	Farm Girls	Nonfarm Boys	Nonfarm Girls	Not planning to go to college: Farm Boys	Farm Girls	Nonfarm Boys	Nonfarm Girls
Professional, technical, and managerial	55.3	85.7	80.1	79.9	16.9	25.7	27.6	26.0
Clerical, sales, service, agriculture and homemaking	37.8	14.3	10.0	19.0	56.6	71.9	18.6	70.1
Skilled and semiskilled	3.8	0	5.9	0	18.0	.5	33.8	.6
Unskilled and other[a]	3.1	0	3.9	1.0	8.5	1.9	19.9	3.3

[a] Includes armed services.

the farm boys and 28 percent of the nonfarm boys not planning on college hoped to go into these occupations.

Similar differences were found among the girls. In the group with college plans, 80 percent of the nonfarm girls and 86 percent of the farm girls hoped to go into professional, managerial, and technical jobs. Among those not planning on college, the figure was about 26 percent for both farm and nonfarm girls.

As might be expected, the students who wanted to go to college had different interests in high school than those who didn't choose to attend college. More than two-thirds of all those planning on college indicated that their favorite subjects were academic studies, such as science, English, and mathematics. Those not going to college tended to prefer business or manual work. Within this group, manual work was preferred by 58 percent of the farm boys, and business by 48 percent of the nonfarm boys.

Implications

Serious implications arise from the fact that 60 percent of the students were not planning on college. These implications are further complicated by the significant differences between the test scores of this group and the scores of the students planning on college.

One implication is that students not going to college should have a different kind of education or training than the type offered in their high schools, which usually emphasizes college preparation. Such training might well include post-high school courses related to the student's interests and capabilities. At present huge sums are spent for the continuing education of the minority going to college. Very little training beyond high school is available for the majority not planning to attend college.

According to a pilot study in Sullivan, Illinois, very few of the rural youngsters not planning on college feel prepared to take a job. About 90 percent of the boys in the pilot study and 81 percent of the girls believed that they needed more preparation and training.

The same study showed that most rural young people wanted to live in the country or a small town. This included 76 percent of the boys and 75 percent of the girls planning to go to college, and 72 percent of the boys and 83 percent of the girls not planning on college. Yet most rural youth will have to find employment in the larger towns and cities, as there just aren't enough jobs in the rural areas. Only one out of five of rural youths will be able to work on the farm.

Obviously, these young people need preparation that will fit them for the jobs available, especially in urban areas. Although the most rapidly expanding occupations are those requiring the most advanced professional and technical education, 90 percent of the jobs, according to the U.S. Department of Health, Education, and Welfare, are to be found in the clerical, sales, craft, service, skilled, and semi-skilled occupations. The U.S. Office of Manpower Training states, "To be prepared for a complex and varied world of work, mostly in urban areas, post-high school education and training of rural youth must be oriented toward present and future labor markets." Equally important, it must be oriented to living in urban and suburban areas. It must therefore be a combination of vocational, technical, and life-adjustment training.

Behavior of Tractors on Roadside Slopes

ROSCOE L. PERSHING

Our new interstate highways are greatly increasing the problems of establishing and maintaining roadside cover. Each mile of highway adds 30 acres of roadside to be maintained, and each interchange adds 40 acres. Much of this added area has slopes up to 50 percent (2:1) on normal interstate right-of-ways and even 67 percent (1.5:1) on suppressed highways.

Thus it has become necessary to build machinery that will handle large, steeply sloping areas efficiently. The present study grew out of this need. The aim was to develop a method of predicting vehicle behavior so that safety of operation as well as functional design could be improved.

The mathematical model

A mathematical model was set up for the geometric conditions shown in Figure 1, which is a line diagram of a tractor operating along a control line that may be considered a slope contour. The slope was downhill to the left of the tractor so that the right side of the vehicle was at the higher elevation. A mower bar was oriented on the uphill side of the tractor.

Model equations indicated the attitude of the tractor in relation to the control line. This was described by angles of yaw and steer. Lateral stability of the vehicle and the potential force with which it could resist sliding were also found.

All these characteristics — yaw, steer, lateral stability, and potential side force — plus forward velocity, were studied for various degrees of slope as the tractor operated along the control line. Calculations were made for a level surface, then the slope was increased, 1 percent at a time, until it was steep enough to cause failure of some kind. By changing certain parametric values, it was possible to predict the behavior of a number of actual and hypothetical tractors.

Field data were necessary to complete the knowledge required for writing the model equations. Tractors were tested on slopes that were as uniformly covered and as plane as could be found, so that mathematical assumptions would be as accurate as possible. The steepest slope was 45 percent. A steel tape was stretched along the slope as a "control line" (Fig. 2). This line was a reference for angular measurements. The slope of the tractor frame was measured with a pocket level.

Characteristic curves

After computer solutions of the mathematical model were found, curves were plotted for each actual and hypothetical tractor-mower unit, to show the changes occurring in yaw, steer, lateral stability, potential side force, and forward velocity as the slope was increased.

The curves for one actual unit are shown in Figure 3. As the slope increased, the yaw angle increased exponentially, causing a loss in forward velocity. The yaw angle was determined from the functions of the creeping angles of the tires. Side-slipping was included as part of the creep. Lateral stability decreased almost linearly as the slope increased, until finally the large yaw angle began to improve the stability. This same yawing action, however, caused a rapidly decreasing front end reaction.

The curve for potential side force was plotted to show how much more side force could be maintained than was actually occurring at any given slope. Failure by sliding took place when the curve passed through zero.

Possible changes in design

Effects on lateral stability of different tread widths and front hinge heights were computed mathematically. Three levels of hinge height were tried with each of two tread widths. Changes in tread width affected stability relatively more than did changes in hinge height.

Several hypothetical changes in vehicle design were also studied. For one of the tractor-mower units, it was shown that steering with the rear wheels instead of the front ones would decrease yaw angle for operation on a given slope. Four-wheel steering could eliminate yaw altogether.

For this same unit, front steer would give the greatest lateral stability, but the least longitudinal stability. The four-wheel steering design would give greater longitudinal stability because, with the prevention of yaw, the front end would not be elevated. Some lateral stability, however, would be sacrificed with four-wheel steering.

Individual steering angles were found to be greater for a vehicle with four-wheel steering than for one with only front or rear steering. Also, for one tractor, the steering angle for front end steering would be of the same magnitude as that for rear end steering, but in the opposite direction.

Each of these computations was based on the specifications for a particular tractor and the results would not necessarily apply to other tractors. However, the specifications were taken from typical and conventional vehicles, and similar trends and results could be expected in similar vehicles.

The greatest problems

Lack of potential side force was the cause of all failures in the conventional tractors studied. On the slopes tested, sliding was the mode of failure always experienced during

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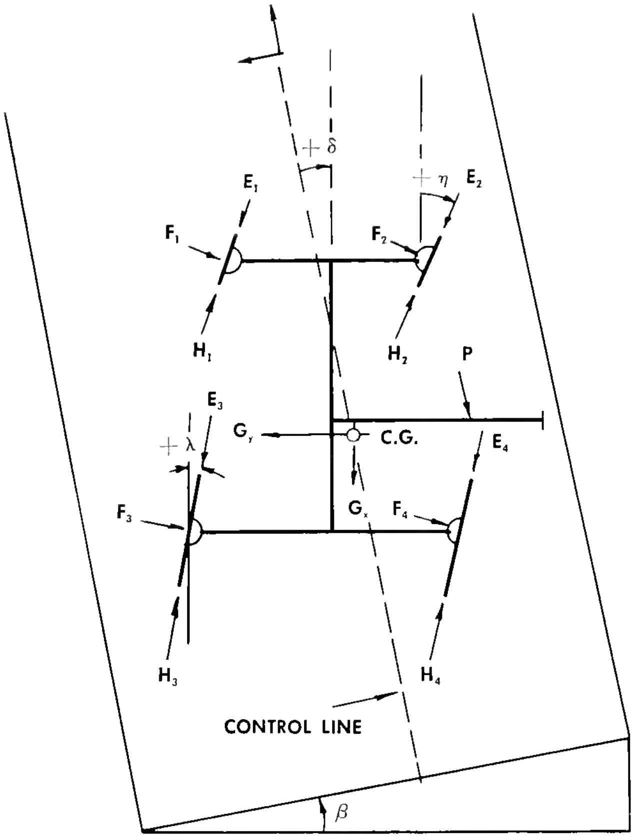
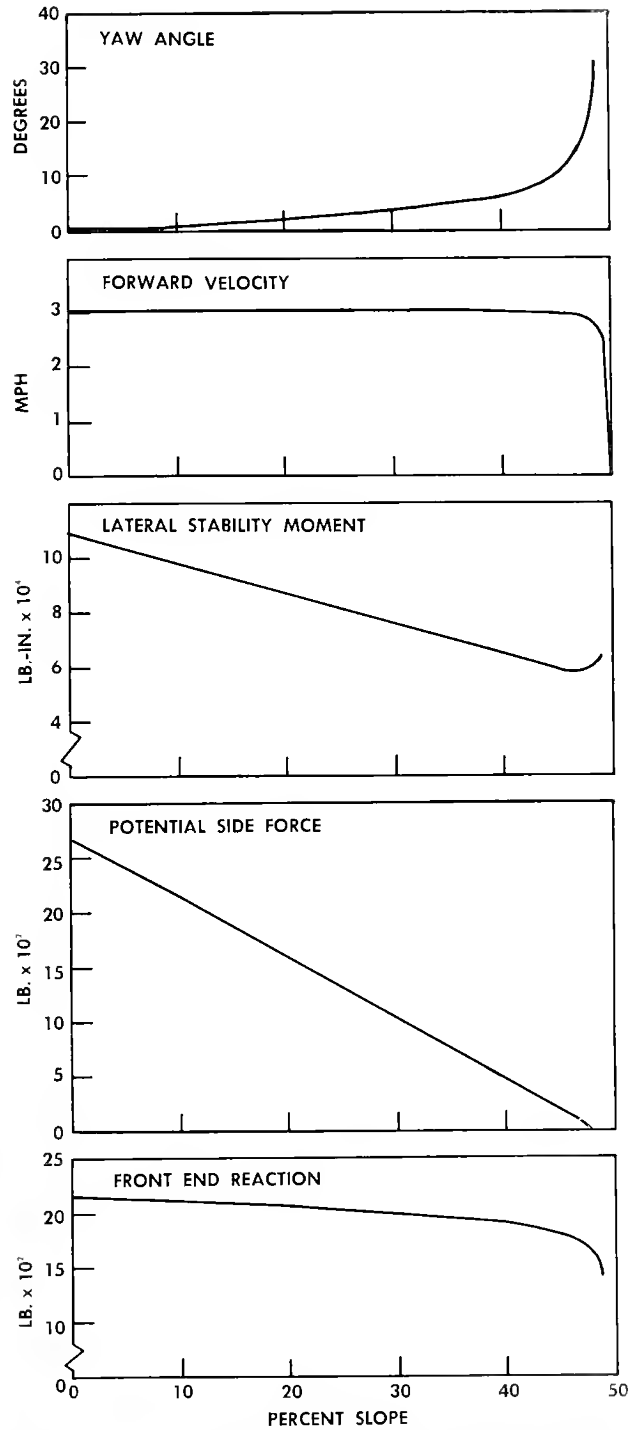
Roscoe L. Pershing is Instructor in Agricultural Engineering.



Line diagram of the problem. Symbols have these meanings: F — side force or reaction force due to friction (F_1, left front wheel; F_2, right front wheel, etc.); E — rolling resistance; H — tractive effort; P — external load (on mower bar); G — weight force (G_x = weight force in x-direction, etc.); C.G. — center of gravity; δ — yaw angle; λ = rear steer angle; η — front steer angle; β — angle of slope inclination. (Fig. 1)

Typical tractor with rear-mounted rotary mower. White line represents control line along which tractor operates. (Fig. 2)



Characteristic behavior of International 340 tractor with side-mounted sickle-bar mower. (Fig. 3)

operation. Hence, potential side force is the most critical characteristic that must be improved.

The largest problem encountered in the construction of the mathematical model was that of the creep behavior of the tires. This area of study should receive high precedence in future research in this field.

Other characteristics may also cause problems, but at present they are relatively minor in steady-state behavior. Their importance may be greater in dynamic behavior, which has not yet been studied.

Extension Workers Hear Outstanding Speeches

ROBERT A. JARNAGIN

CHALLENGES to Extension education and the professional abilities needed to meet these challenges were the main points emphasized by speakers at the annual Fall Conference of the Cooperative Extension Service last October.

Wickens

Mrs. Aryness Joy Wickens, consumer program adviser, U.S. Department of Labor, centered her discussion around the changing society in which we live. One basic economic and social change that will affect future Extension Service planning is the population explosion. While this population increase will provide a broadened market for the nation's goods and more workers to produce these goods, we are rapidly becoming a nation of youngsters and oldsters. By 1970, we expect that 42 percent of the people will be under 25 and 20 percent over 55.

The increasing percentages of young and old people create economic, social, and educational problems. Special educational and guidance programs are needed for young people, especially the high school dropouts, and for older people whose skills are outmoded. Extension programs must be adapted more rapidly to the needs of these audiences. The Extension Service can have a real influence in furthering community effort toward training people for the jobs of tomorrow.

Watts

Director Lowell H. Watts of the Colorado Extension Service said that, to him, the challenge of Extension lies in its opportunities to provide leadership in a real, practical, and meaningful way. Our dynamic society, however, makes leadership more difficult than it was in the slowly changing society of former years. Since organizations tend to resist change during periods while everything else is changing rapidly, Extension workers not only have the problem of keeping Extension's programs up to date, but they also will have to deal with other organizations having the same problem.

Present-day social and economic changes tend to center around increased complexity, centralization, specialization, interdependence, and impersonality. We seem to be moving toward a more homogeneous society in which locally oriented groups become less autonomous. We find, too, increasing interaction between rural and urban societies and a narrowing of the differences in values and styles of living.

This means that we in Extension must get full knowledge of whom we wish to serve — their needs, wants, and educational requirements; we must draw more upon the full resources of the Land Grant universities; and we must keep up with the rapid changes in both population and knowledge. The Extension Service of tomorrow should be oriented to helping county people use the total Land Grant university. Agriculture and home economics will remain a vital part, but only a part, of a larger program.

Halcrow

According to Dr. Harold Halcrow, head of the Department of Agricultural Economics, significant social and economic changes are occurring in agriculture as the result of three trends: (1) the strong growth in output and markets, (2) major shifts in production and marketing practices, and (3) the decrease in farm population and growing urban influences in the farming community.

Gross farm output has increased by about one-third in the last 20 years and is continuing upward by about 2.5 percent a year. The proportion of consumer income spent for food has been declining slowly until food now takes less than one-fifth of disposable income. This increase in output, on the other hand, has weakened the terms of trade of U.S. farmers, making farm prices low in relation to prices paid for goods used in farm production.

U.S. agriculture has considerable growth potential, mainly for such industrial products as tractors and machinery. While the shifts from labor to capital inputs and from smaller to larger farms are important, no rapid or substantial shift away from the present farm business structure appears imminent.

Ratchford

Dean C. B. Ratchford of the Missouri Extension Service pointed out that Extension has contributed much to the agricultural revolution. But some now view Extension as being too conservative and inflexible.

What this image of Extension means is that we Extension workers must more strongly support the principle of continuing education for all people, we must continue to improve staff competence, we must become known as educators in the university sense, we must cooperate with other university extension programs, we must broaden our own programs, we must develop a role that is different from that of the other agencies serving agriculture, and we must allocate our resources and make the organizational adjustments that the times demand.

Speeches studied

The Illinois Extension staff has been studying the full text of these major speeches delivered on the occasion of Extension's fiftieth anniversary. The opinions of these outstanding speakers are being analyzed in the light of the particular opportunities and needs in Illinois.

Robert A. Jarnagin is Assistant Extension Editor.

RESEARCH IN BRIEF

Economic Growth of the EEC, United Kingdom, and the United States

During the 1952-1962 decade, European countries made a faster economic growth than has ever before been recorded for any group of industrial countries in a comparable period.

In 1962, the purchasing power per person of the six countries in the European Common Market (EEC) averaged $1,682 in U.S. 1962 dollars. This was 74 percent above the 1952 figure of $965. During this same period the purchasing power per person in the United Kingdom increased from $1,171 to $1,737; and in the United States, from $2,517 to $2,981.

The following figures for the individual countries are the gross national products adjusted to reflect purchasing power of national currencies in U.S. 1962 dollars:

Country	*Purchasing power per person* 1952	*Purchasing power per person* 1962	*Pct. increase*
W. Germany	$ 948	$2,035	115
Luxembourg	1,655	2,003	21
France	1,320	1,842	40
Netherlands	921	1,572	71
Belgium	1,240	1,531	23
Italy	618	1,197	94
Common Market	965	1,682	74
United Kingdom	1,171	1,737	48
United States	2,517	2,981	18

(Sources: OEEC; UN; Economic Almanac; U.S. Statistical Abstract; and the New European Common Market, Chase Manhattan Bank, 1961.)

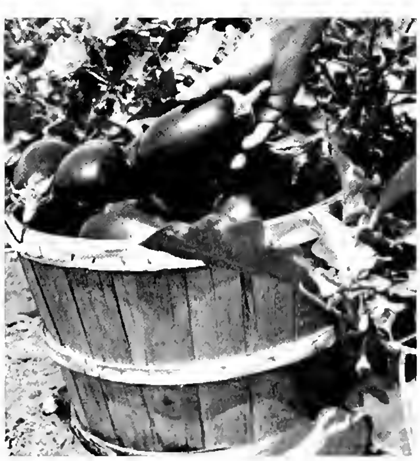
The principal factors responsible for the unusual increase in purchasing power in the EEC were: (1) breaking down of trade barriers for labor, capital, and industrial know-how; (2) use of Marshall Plan funds for reconstruction; (3) military protection provided by integration of the United States in the NATO alliance; (4) a desire to return to peace-time living standards; (5) introduction of the most modern production machinery to replace that destroyed by the war; and (6) investment by about 1,300 American firms in EEC between 1958 and 1962.

The implications of the EEC for the United States are: (1) As income has increased in the EEC, exports of U.S. goods to these countries have increased at an even greater rate, thus meaning more jobs for U.S. workers. (2) Increased export of U.S. goods to EEC has improved the balance-of-payments position of the United States. (3) As living standards have increased, Communism has declined as a dangerous internal force. (4) Economic integration of France, West Germany, and other countries has indefinitely postponed the possibility of another war between these countries. — *Roland W. Bartlett*

Eggplant, a New Crop for Southern Illinois

Eggplant is potentially a good crop for limited production in southern Illinois. A warm-season crop, it has temperature and cultural requirements similar to those of the tomato.

In each of the past four years, eggplant has been grown successfully



The Black Magic Hybrid eggplant.

at the Dixon Springs Agricultural Center. Plants were field-set during the first week in May, after all danger of frost was past. Harvesting began in late June or early July and lasted 5 weeks.

Ten varieties have been compared in trial, and three — Burpee Hybrid, Black Magic Hybrid, and Black Beauty — are recommended. Their yields, in bushels per acre, were as follows:

Year	*Burpee Hybrid*	*Black Magic Hybrid*	*Black Beauty*
1961	...	417	...
1962	...	901	...
1963	711	632	464
1964	1,001	705	621
Average	856	664	542

Market prices in Chicago have ranged from $3.00 to $4.50 a bushel during July, tapering off in early August. Frequently, supplies of eggplant have been too small to quote in northern markets during early and mid-July.

Growing eggplant requires more skill and care than growing either peppers or tomatoes. Transplants are best grown in containers such as wood veneer bands or peat pots. The young plants must be kept growing vigorously and should have four or five leaves when set in the field. Eggplant cannot tolerate frost or a check in growth due to low temperatures.

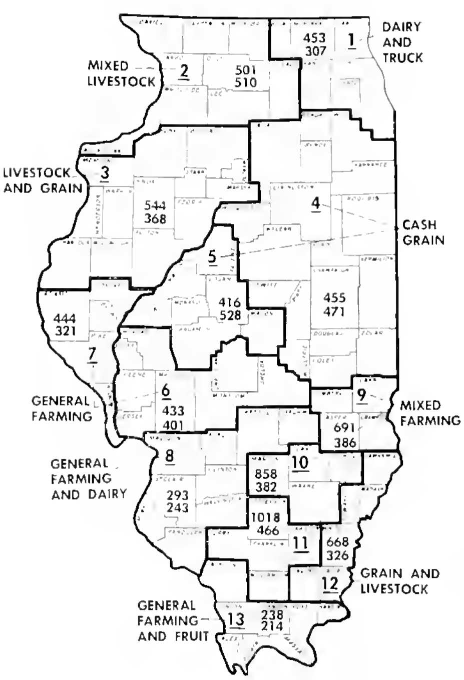
Insects and diseases are serious problems to the eggplant grower. To keep soil-borne diseases at a minimum, eggplant should be planted in fields which have not been cropped to tomatoes, peppers, eggplant, potatoes, or strawberries for at least three years. A strict insect-control program must be carried out.

On a commercial scale, a vegetable farmer in Union County grew 5 acres of eggplant, the Black Magic Variety, for the first time in 1964. The transplants were grown in 3-inch peat pots in new plastic greenhouses built especially for growing

vegetable plants. During July, 2,800 bushels were harvested. They were sold in St. Louis, Kansas City, and Chicago. In a year when prices were lower than usual, returns averaged $3.02 a bushel. Growing costs were $0.30 a bushel and harvesting and marketing costs were $1.57, leaving a net return of $1.15 a bushel, or $644 an acre. This grower believes that his experiment was highly successful, and he has a new high-income crop to diversify his vegetable-growing operation. — *J. W. Courter and C. N. Glover*

Short-Term Agricultural Credit Use Has Increased Dramatically in Illinois

Levels of short-term loans in Illinois are currently being studied in the Department of Agricultural Economics. Information for the study is derived from the three primary reporting sources of non-real estate loans in Illinois. These are insured commercial banks, Production Credit Associations, and the Farmers Home Administration.



Percentage changes in short-term agricultural loans (upper figure) and bank loans for all purposes (lower figure), in each type-of-farming area, 1947-1963.

The dollar volume of loans from these sources in 1947, 1952, 1957, 1962, and 1963 has been tabulated for the 13 type-of-farming areas in the state. The expansion in short-term credit between 1947 and 1963 has been dramatic, amounting to about 450 percent for the state. As shown on the accompanying map, the percentage increases have not been completely uniform throughout the state.

The market for all farm credit, including short-term as well as real estate credit, has expanded proportionately with the rest of the credit market in Illinois. For the state as a whole, agricultural credit represents only 5 percent of the reported credit market, but if Area 1, which includes Chicago, is excluded, agriculture represents 20 percent of the total (bank) credit market.

Currently research is being conducted to determine the relationship between short-term agricultural loans and farm income in the different type-of-farming areas. The relationship between total personal income from all sources and total bank loans for all purposes, both agricultural and nonagricultural, will also be analyzed. This research is part of a larger project on the structure of capital markets serving agriculture.

For a more detailed account of the study to date, see the January, 1965, issue of *Illinois Agricultural Economics*, which may be obtained by writing to the Department of Agricultural Economics, 305 Mumford Hall, Urbana, Illinois. — *L. P. Fettig*

Microwave and Conventional Cooking Methods Compared

Do the nature and speed of microwave cooking result in better retention of nutrients in foods cooked this way than in those cooked conventionally? How does microwave cooking affect palatability? Answers to these questions have been sought in the food research laboratory of the Department of Home Economics. Ascorbic acid retention was measured in vegetables cooked by microwaves and by a conventional method; and thiamine retention was measured in meat. Both the vegetables and the meat were rated for palatability.

Seven fresh vegetables (broccoli, cabbage, cauliflower, peas, snap beans, soybeans, and spinach) were cooked by the two methods. No statistically significant differences were found in the amounts of ascorbic acid retained. This was also true of frozen broccoli, snap beans, and spinach cooked after 4 months and 8 months of freezer storage.

For some vegetables, mean total palatability scores were significantly higher after microwave cooking than after conventional cooking; for other vegetables, the reverse was true. However, the differences in scores were always too small to be of practical importance.

For the meat comparisons, paired boneless beef rib and pork loin roasts, beef loaves, and ham loaves were used. One of each pair was cooked by microwaves; one by a conventional method. The paired products were cooked as nearly as possible to the same degree of doneness. This was well-done for pork roasts, beef loaves, and ham loaves, and medium-rare for beef roasts.

The percentage of thiamine retained in the lean of pork roasts and in beef and ham loaves was similar after both methods of cooking. Approximately 20 percent less thiamine was retained in the lean portion of beef roasts cooked in the electronic range than in the lean of those cooked conventionally.

Beef and pork roasts did not develop an attractive brown outer surface when cooked in the electronic oven, and the interior color was uneven. The outer portions of the muscles were hard and dry and the meat was less tender and juicy than that cooked conventionally. Judges gave palatability ratings of fair to the roasts cooked by microwaves, while the conventionally cooked roasts were rated as good.

The beef loaves and ham loaves were judged somewhat less desirable in appearance and color after micro-

wave cooking than after conventional cooking. Flavor ratings, however, were good, regardless of the method of cooking. — *Anne M. Kylen and Frances O. Van Duyne*

Illinois Population Growth Slackens As Migration Pattern Is Reversed

Between April 1, 1960, and July 1, 1963, Illinois population grew by 3 percent, reaching 10,381,000. The average annual rate of growth during this 39-month period was thus 0.9 percent — considerably below the 1.5 percent rate of the 1950-1960 decade.

Illinois population growth during the 1960-1963 period was smaller than the national growth, which was 5.2 percent. The increase in the North Central region, however, was still smaller — 2.5 percent. The average annual rate of growth in the region declined from 1.5 percent in the 1950-1960 decade to 0.8 percent in 1960-1963.

More significant than the decreased rate of population growth in Illinois is the fact that the pattern of migration was reversed. In each of the two decades prior to 1960, Illinois gained population through migration. In the total net interchange of population between the states, there were 106,000 more persons who moved to Illinois from other states in 1940-1950 than who left Illinois. In the 1950-1960 period the net in-migration gain amounted to 124,000.

Between April, 1960, and July, 1963, Illinois had a net out-migration of 124,000 — 1.2 percent of the 1960 population. During this period, the state's natural increase amounted to 425,000, resulting from 762,000 births and 337,000 deaths.

All 12 states in the North Central region had net losses through migration in 1960-1963. The total regional loss amounted to almost 1 million, or 1.9 percent of the 1960 population. In addition to Illinois, states losing more than 100,000 were Michigan (186,000), Ohio (130,000), and Iowa (112,000). Sizable losses were also recorded in Minnesota (96,000), Missouri (89,000), and Wisconsin (76,000).

The North Central region was the only major region experiencing a net loss in population through migration. The West showed the largest gain (4.5 percent) followed by the South (1.0 percent) and the Northeast (0.8 percent).

Undoubtedly many factors are responsible for the reversal of the long-time pattern of migration into Illinois. An important factor, however, may be that the heavy migration of nonwhites from the South is slowing down. Between 1940 and 1960 the estimated net migration of nonwhites into Illinois amounted to approximately 427,000. A more detailed analysis of the demographic and other factors associated with changes in migration patterns must await additional data. — *C. L. Folse*

Cull Hardwoods Can Be Killed With 2,4-D Amine

For maximum production of quality hardwood timber, undesirable trees must be eliminated. Where fuelwood and pulpwood outlets are unavailable or impractical, cull hardwoods may be killed with herbicides.

An effective and economical herbicide for this purpose is an undiluted solution of 2,4-D Amine salts applied to basal trunk cuts. The Forestry Department has tested this method at the Dixon Springs Agricultural Center in southern Illinois. On a 10-acre upland hardwood stand, predominantly oak and hickory, 180 trees were treated in the early spring — the most effective time of year for killing trees.

Two criteria — species and size — were used in selecting trees for treatment. Red oak, white oak, and hickory in 4-, 8-, and 12-inch diameter classes were selected on a variety of sites. Overlapping cuts were made so that they girdled the trunks within 6 inches of the ground line. Commercial preparations of 2,4-D Amine, 4 pounds acid equivalent per gallon of solution, were applied with a metering injector. Approximately 1 milliliter of chemical was injected into each of the cuts.

This method has appeared to be extremely effective on all species groups and size classes tested. After the first growing season, complete crown kill was obtained on 97 percent of the oak and 38 percent of the hickory. One year later all of the oak and 93 percent of the hickory were dead. Possibly the hickory's tough bark prevented the cutting bit from reaching the sapwood, thus delaying complete crown kill. No basal sprouting occurred above or below the cuts on any of the species.

Additional tests are being made to study the effects of spacing the cuts 3 inches apart instead of overlapping them. The same herbicide applied in cuts as far as 7 inches apart has been very effective on some species in the southeastern states. Although spacing would reduce the application time and the amount of herbicide needed, it should be used only if it gives good results.

If a commercial injector isn't available, it is suggested that an axe frill be made near the ground line. The concentrated herbicide may be applied with a pliable squeeze bottle. — *W. A. Geyer*

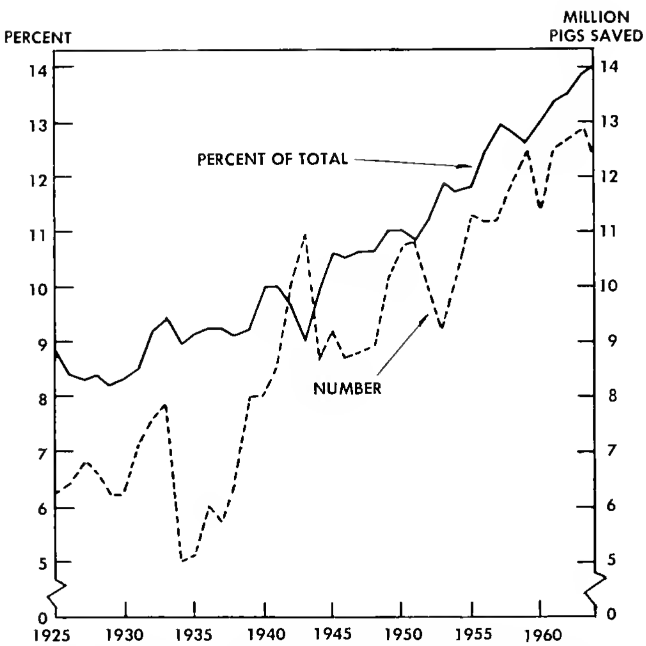
Killing cull hardwoods with 2,4-D Amine.

FARM BUSINESS TRENDS

Among the states, Illinois ranks second only to Iowa in the production of hogs. Receipts from sales of hogs in Illinois averaged $440 million a year in the last five years and provided one-fifth of all cash receipts from all agricultural marketings.

Hog production is a growing industry in Illinois. It has doubled in the past 40 years. The growth of the industry has been quite steady with two exceptions: In the middle 1930s production was drastically reduced when severe drouths cut the corn crops. During World War II production was expanded sharply for two years when surplus stocks of corn and wheat were converted into pork to provide food for our civilian and military personnel.

The hog business has been growing faster in Illinois than in the nation as a whole. Illinois farmers boosted their share of the nation's hog business from 8.2 percent in 1929 to 14 percent in 1964 (Fig. 1).



PIGS SAVED IN ILLINOIS: Total number and percent that Illinois total is of U.S. total. **(Fig. 1)**

MONTHLY HOG PRICES: 6-year averages, 1959-1964. **(Fig. 2)**

Farmers are spreading hog sales more evenly throughout the year than formerly, but there is still an important seasonal pattern of hog prices. Figure 2 shows the average monthly prices during the past six years. Prices did not vary much from November through May, but they rose sharply in June and July, then declined slowly until November. The summer price bulge reflects small market receipts, which in turn result from small sow farrowings in winter.

Some farmers can take advantage of the seasonal variation in hog prices. They can plan their production so that they can sell a large share of the year's output in the high-price months. This usually requires the use of some rather expensive equipment and a good deal of labor during the winter.

On some other farms farrowings can be concentrated largely in the warm spring months so that no expensive equipment will be needed and labor requirements can be kept low. Pasture can be used to reduce the amount of grain needed. No heavy hogs will be on hand during the hot summer months. Hogs can be finished during the cool fall months and sold during the late fall and early winter at prices only a little below the yearly average. — *L. H. Simerl*

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ILLINOIS RESEARCH

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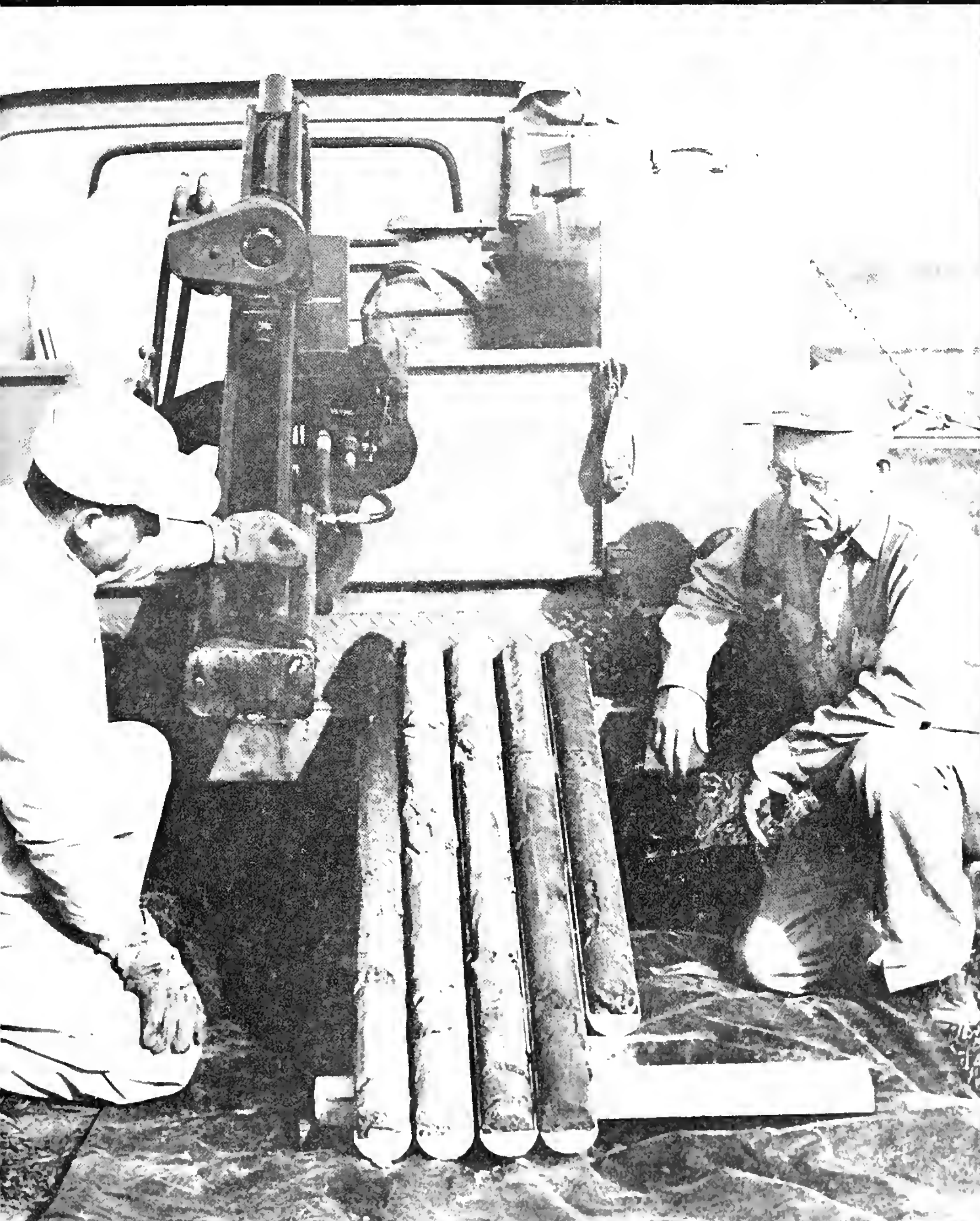

IN THIS ISSUE

A new hydraulic soil-coring machine, mounted on a ¾-ton truck, permits scientists to take soil samples with a minimum of time and effort (page 10).

Volume 7, Number 2 COLLEGE OF AGRICULTURE URBANA, ILLINOIS

ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

Spring, 1965 Volume 7, Number 2

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M. B. Russell . . . . Director

Adrian Janes . . . . Station Editor

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

NEWS AND VIEWS

Problems of the community, the family, and the consumer are going to receive increased emphasis in our research program. The need for such emphasis is clearly stated in the following quotation:

> The United States has achieved production in abundance, and at the same time many of its people have more free time than citizens of other nations. This accomplishment serves to underscore the ever present question, "Are we, as a Nation, using our abundance in a way that contributes most to quality of living?"
>
> Our ability to live and work with one another, to use our income and other resources wisely, and to solve our social problems has not advanced as rapidly as our ability to produce materially. Yet, presumably, the ultimate objective of all production is for human betterment.
>
> In spite of our advancement in skills and technical knowledge, the levels of living of many people and the public services and facilities of many communities are below those widely accepted as normative in American society.
>
> We now urgently need information to guide individuals and families in decisions that will contribute to their development and to the utilization of material resources so that the long-range well-being of individuals, families, and society will be enhanced.
>
> Research directed along these lines will concern itself with people and their quality of living. Attention will be focused on the family or the individual in its social and cultural milieu, and on the processes whereby resources are allocated to obtain the goods, services, and experiences desired.
>
> The ultimate goal is to discover the method whereby people can maximize their satisfaction and well-being through both public and private means. Assisting people to achieve this goal requires an understanding of the factors affecting behavior and the consequences of decisions in terms of both the individual's desires and the welfare of society. Research can contribute needed insights.

The above quotation was from the report of a work group that had been appointed by the Administrator of the Cooperative State Research Service, U.S. Department of Agriculture. Their task was to review research conducted by land-grant institutions in the areas of the community, the family, and the consumer. Two Illinois staff members were in the group — Dr. Janice Smith and Dr. Marilyn Dunsing. — *M. B. Russell*

Light in the Cornfield

J. W. PEEK and J. W. PENDLETON

In our first botany course, most of us learned that light is necessary for photosynthesis, and that this is the process by which plants manufacture food. The corn plant is no exception. Corn loves light — the more the better!

We know that one sure way to reduce corn yields is to shade the plants artificially. This is particularly true during the ear-filling stage. In 1964 we wondered what would happen to corn yields if extra sunlight was made available to the middle and lower leaves that generally grow in shade.

A "light-rich" situation

To create a "light-rich" situation, we built large reflectors (8 feet high and 24 feet long) of wood covered with heavy-gauge aluminum foil. These were placed on the north side of corn rows planted at the rate of 32,000 plants per acre.

Aluminum-covered reflectors increased the amount of light received by the corn plants.

The table shows the yield and characteristics of the plants growing in these light-rich areas and in adjacent areas where light was normal. Yields were 50 bushels higher in the reflector areas. This was a difference of about 25 percent. The plants with extra light were 2 inches shorter but had larger stalks.

We attribute these differences primarily to light, although admittedly there was an increase in temperature immediately in front of the reflector surface.

Information not new

Actually the information obtained from this experiment is not new. You see this tremendous yield response of corn to light almost every fall as you drive down the roadways of Illinois. Large well-filled ears hang like yellow pennants from every stalk along the edge of the field. If you step three rows into the field the ears may be only half as large, although there may be exceptions in years when hot winds occur.

Thus, the research challenge is to get more light on the corn plant or to trap all we can. In fact, with our present varieties, light may well be the limiting factor in our search for higher yields.

Some past experiments

In agronomy experiments several years ago, four rows of corn were alternated with four rows of soybeans. Because of the favorable light situation, corn yields from these strips were 20 to 25 percent higher than from solid corn plantings. Soybean yields, however, were reduced by about the same percentage because the beans had to grow in the shade of the corn.

In other experiments the yields from corn rows planted 80 inches apart were 10 to 20 percent less than yields from standard 40-inch rows.

Effects of Extra Light on Corn Plants

Item measured	Normal light	"Light-rich"	Difference
Grain yield			
Bu. per acre	198.9	250.5	+ 51.6
Lb. per plant	0.3481	0.4385	+0.0904
Plant height, in.	95.0	93.1	− 1.9
Mean stalk diameter, cm.			
Internode No. 2	1.19	1.30	+ 0.11
Internode No. 5	1.58	1.72	+ 0.14
Internode No. 10.	2.05	2.07	+ 0.02

Present approach

Our present approach is to try to capture on the leaf surface, as early as possible in the season, all the light or solar energy falling on an acre of corn. This means not only more light for photosynthesis, but also a net saving in soil moisture. The light energy that reaches the ground surface raises the temperature and thereby increases evaporation of soil moisture, especially on a moist soil.

To fully accomplish our purpose of capturing light will require changes in present planting patterns. A narrowing of rows is one method. At a given planting rate the distance between individual plants in narrow rows is greater than in 40-inch rows. As a result, competition may be reduced for water, nutrients, and light. Increased shading of ground surfaces also discourages growth of weeds which compete for water and plant food.

At high yield levels and high plant populations, our recent trials have shown a 5- to 15-bushel advantage for 30-inch rows as compared with 40-inch rows. A good share of this increase may be attributed to better use of the sun's light and energy.

J. W. Peek is Assistant in Crop Production; J. W. Pendleton, Associate Professor of Agronomy.

EMPLOYMENT OF THE WIFE-MOTHER: Effect on Four Types of Family Expenditures

JEANNE L. HAFSTROM and MARILYN M. DUNSING

When a wife-mother takes a job outside the home, where does her money go? Do her family's economic choices differ from those of one-earner families?

No known studies have presented data on the expenditures, during marriage, of two-earner and one-earner families. To fill this gap, a study was undertaken of 25 families in which the wife had been employed for at least half her married life and 25 families in which the husband was the only earner.

The two groups were matched as to ages, number and ages of children, length of marriage, and husband's income. The husbands, all nonacademic employees of the University of Illinois, earned from \$5,000 to \$6,500 a year. All couples had been married at least 5 years but no more than 16 years, and had one to four children. Each group was divided into three subgroups according to length of marriage.

The interview-questionnaire method was used to collect information on current and past income and expenditures. In this article emphasis is placed on expenditures during marriage for houses, equipment, home furnishings, and automobiles.

Income

Average annual income of the two-earner families in 1963 was \$8,665, 36 percent higher than that of the one-earner families (\$6,373). The husband's contribution in the two-earner families (\$5,845) was slightly smaller than in the one-earner families (\$6,305). Up until 1963, average annual income during marriage was \$6,617 for two-earner families; \$5,448 for one-earner families.

Jeanne Hafstrom is Instructor, Marilyn Dunsing, Associate Professor, both in Family Economics.

Housing expenditures

Housing costs included down payments, as well as mortgage and rent payments. On the average, during each year of marriage, two-earner families spent 13 percent more for housing than one-earner families. In both groups, the average annual amount decreased as length of marriage increased. Two-earner families averaged \$87 a month for housing costs; one-earner families, \$77.

One-earner families paid an average price of \$11,997 for their houses; two-earner families, \$14,410, or 20 percent more. Down payments averaged \$745 for one-earner families; \$1,811 for two-earner families.

Number of rooms per house was almost the same for both groups — 5.28 for two-earner families and 5.12 for one-earner families.

Expenditures for equipment

The number of appliances bought by both groups of families increased with length of marriage. As would be expected, the two-earner families married the longest spent the most for replacements. This was not true, however, of one-earner families. Average replacement rate for two-earner families was higher than for one-earner families except in the subgroup married the shortest time (5 to 8 years). One-earner families in this subgroup started out with more used equipment than two-earner families, which would partly explain the higher replacement rate.

On the average, two-earner families spent 23 percent more for equipment during each year of marriage than did one-earner families.

Freezers. Of the large appliances, freezers accounted for the biggest difference in expenditures during marriage. Two-earner families spent about two-thirds more than one-earner families. Forty-eight percent of the two-earner families and 36 percent of the one-earner families owned freezers. Both groups spent more for freezers as length of marriage increased.

Refrigerators. Two-earner families, on the average, spent 31 percent more for refrigerators than did one-earner families. In the two-earner group, average expenditures increased with length of marriage. This was not true in the one-earner group; however, two of the couples married the longest had received refrigerators as gifts.

Ranges. The expenditure for ranges was about 60 percent higher in two-earner families than in one-earner families. No relationship existed between average amount spent and length of marriage.

Washers and dryers. All families had access to laundry facilities in their homes, but two one-earner families did not own the equipment. In addition, one family in each group had nonautomatic washing machines. The others, 24 two-earner and 21 one-earner families, owned automatic washers, with the average cost being about the same in the two groups. Twenty two-earner families and 21 one-earner families owned dryers, but the two-earner group spent 34 percent more for this item than the one-earner group.

Vacuum cleaners. Two-earner families spent 33 percent more on vacuum cleaners than one-earner families. For both groups, the average amount spent on this item increased with length of marriage.

Sewing machines and power mowers were the only large appliances on which one-earner families spent more than two-earner families — 11 percent more for sewing machines and 54 percent more for power mowers. Twenty-one one-earner families

owned power mowers as compared with 16 two-earner families.

Small appliances. On the average, two-earner families spent 12 percent more for small appliances than one-earner families. Both groups, however, spent relatively little for these items. One reason was that 64 percent of the small pieces of equipment had been gifts. Families married the fewest years had received the most gift appliances.

Home furnishings

In both one- and two-earner families, those married the longest had spent the most during marriage for present home furnishings.

The replacement pattern was similar for both groups — two-earner families averaged 2.36 replacements per family; one-earner families, 2.32 replacements. For two-earner families, the average replacement rate increased with length of marriage, but this was not the case for one-earner families. Both groups replaced television sets oftener than any other item of home furnishings.

The two-earner families spent 34 percent more for home furnishings than the one-earner families. This is partly explained by the fact that one-earner families purchased 33 percent more pieces of used furnishings than two-earner families.

Television sets were the only item for which one-earner families spent more (12 percent) during marriage than two-earner families. All families, except one in the one-earner group, had television sets. Eight families in each group owned two sets. Six of the sets in two-earner families, as well as three sets in one-earner families, were prizes or gifts, or had been owned before marriage.

Living room and bedroom furniture. Expenditures by the two groups were quite similar, with two-earner families spending only 4 percent more than one-earner families for living room furniture and 8 percent more for bedroom furniture.

Record players. Although two-earner families averaged fewer record players per family (.56) than one-earner families (.72), they spent an average of 64 percent more for this item. One reason was that their record players were all new when bought, whereas 17 percent of the record players in the one-earner families were purchased used.

Dining room furniture. Two-earner families spent 68 percent more on dining-room furniture than did one-earner families. The one-earner group bought more of it used (44 percent) than did the two-earner group (7 percent).

Draperies. About twice as many two-earner as one-earner families replaced their draperies, which largely explains a 78 percent higher expenditure in the two-earner group.

Rugs and carpeting accounted for the biggest difference in expenditures by the two groups. Two-earner families spent almost three times as much for these items as did one-earner families.

Automobiles

Besides a house, a family's most costly single purchase is usually an automobile. Excluding the automobiles owned at the time of marriage, one- and two-earner families spent about the same amount per automobile — $1,109 and $1,130, respectively. The number of automobiles bought by two-earner families averaged 4.04 per family, however, as compared with 3.68 for one-earner families. Consequently, the average total amount spent for automobiles during married life by two-earner families ($4,567) was 12 percent higher than that spent by one-earner families ($4,082).

Among the two-earner families, the average amount spent per automobile was higher for families married the shortest time than for those married the longest. This was not true, however, among one-earner families. The two groups also differed in rate of automobile replacement. For one-earner families, replacement rate increased as length of marriage increased, but this relationship did not exist for two-earner families. Two-earner families bought 47 percent of their cars new; one-earner families, 25 percent.

The average cost of the automobiles owned by the families when interviewed was considerably higher than the average cost of all automobiles owned during their married life — 53 percent higher for the two-earner families and 38 percent for the one-earner families. Although the average age of the present automobiles was the same for one- and two-earner families, the average cost was 13 percent higher for the two-earner families ($1,733) than for the one-earner families ($1,530). This was partly due to the fact that 56 percent of the cars in the two-earner families were new when purchased, as compared with 44 percent in the one-earner families.

Six two-earner families and three one-earner families each owned two automobiles. As an average, the second car cost 14 percent more in the two-earner group than in the one-earner group, but was two years older.

In both one- and two-earner families, average automobile costs, not including costs of insurance and operation, accounted for 7 percent of average family income during each year of marriage. One-earner families made an average automobile payment of $33.61 each month of married life; two-earner families, $38.21.

For two-earner families, a positive relationship existed between average monthly automobile payments and average family income during marriage. That is, the group with the highest average automobile payments had the highest average incomes. Just the opposite was true of one-earner families; those with the highest average payments had the lowest average incomes.

Other studies needed

More studies are needed which provide data on the way in which the wife's employment affects family economic welfare. These data could help families decide whether the wife-mother should seek gainful employment.

CONCRETE WALL PANELS

Self-anchored, continuously insulated panels are designed for houses and other small buildings

E. L. HANSEN

PRECAST concrete wall panels are being increasingly used for industrial and farm buildings. Now two new types of relatively small panels have been developed by agricultural engineers at the University of Illinois. These panels are suitable for houses and other small buildings, particularly where insulated walls are required.

Each panel is anchored to the foundation and is self-supported. Expanded polystyrene insulation is incorporated into the panels so that the insulation is continuous. This is done by letting the polystyrene extend 3/16 inch past the edges of the panel. When the panels are erected, the polystyrene edges are butted, leaving a ⅜-inch-wide joint between the concrete edges of the panels.

Panel I has a single layer of reinforced concrete bonded to a layer of rigid polystyrene foam insulation (Fig. 1). With an interior finish of plaster or drywall applied to the insulation, this panel would be suitable for houses. Panel II is a sandwich panel with a core of polystyrene foam insulation and reinforced concrete facings (Fig. 2). This type would be appropriate for livestock buildings, garages, or similar heated buildings.

Design loads and analysis

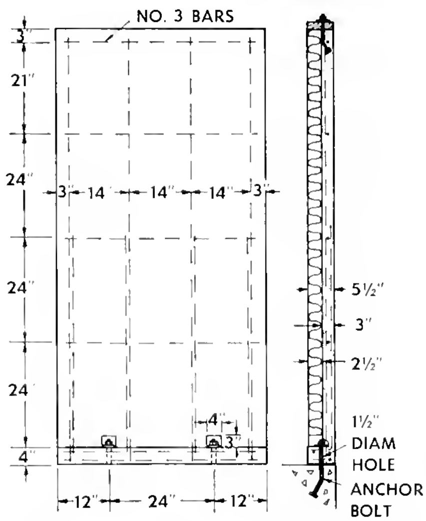
Self-anchored wall panels must provide lateral strength and stiffness against wind loads as well as support for gravity loads. The heavy concrete panels must also withstand tilting and lifting during erection.

A hypothetical building was designed and analyzed mathematically. A building width of 32 feet and a wall-panel height of 8 feet 4 inches were chosen. The roof was assumed to be supported by wood trusses with an estimated weight of 134 pounds per foot of building length. The dead load of roofing was set at 5 p.s.f. Design loads were: snow load, 15 p.s.f.; wind velocity pressure, 15 p.s.f.

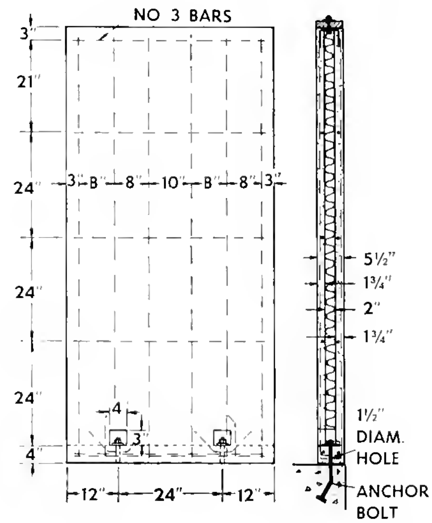
The panel base was assumed to be fixed against translation or rotation. A pinned connection was assumed to join the roof system to the wall panels. For horizontal wind loads, the two walls are essentially cantilever beams tied together by the roof system.

Analysis showed that the bending moment due to wind pressure was the critical load on the panel. By comparison, the effect of snow load plus dead load was insignificant.

Erection stresses were calculated for the panel in a horizontal position, supported at the ends, and loaded by its own weight. The maximum moment, then, was at the center of the panel.



Panel I has a layer of insulation bonded to a layer of concrete. (Fig. 1)



Panel II has a layer of insulation between two layers of concrete. (Fig. 2)

Structural design of panels

A total panel thickness of 5½ inches was chosen so that 2 x 6 lumber could be conveniently used for forms and for the wall plate. The use of 2-inch and 3-inch insulation determined the thickness of the concrete.

The panels were designed for a concrete compressive strength of 3,000 p.s.i. and for intermediate-grade reinforcing steel with minimum yield strength of 40,000 p.s.i. Amount and arrangement of reinforcement for the panels were determined by Part IV of the 1963 ACI Code.

Panel I (Fig. 1) was designed to be cast with the insulated side down. The reinforcement in the lower part of the panel was controlled by the bending moment due to wind load. Since the moment may be applied in either direction, a symmetrical, doubly reinforced section was appropriate. This reinforcement was not

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E. L. Hansen is Professor of Agricultural Engineering.

needed beyond mid-height for wind load, but one layer of steel was extended through the full length of the panel to provide resistance against lifting stresses. Horizontal reinforcement was provided for shrinkage and temperature stresses. Shear and bond stresses were not critical.

Panel II (Fig. 2) was designed on the assumption that the concrete facings bend independently; that is, with no shear connection. Since the design moment for erection was nearly as large as the design moment for wind load, the same amount of reinforcement was specified throughout the panel. The nominal safety factors were calculated to be 2.02 for wind load and 2.17 for erection. Again, shear and bond stresses were not critical.

Casting of panels

One specimen of each type of panel was cast from the following concrete mix:

Type I Portland cement	1.0 cu. ft. (one bag)
Fine aggregate — sand (damp)	2.4 cu. ft.
Coarse aggregate — gravel	2.4 cu. ft.
Water	5.5 gal.
Calcium chloride	2 lb.

The fine aggregate was Torpedo sand; the coarse aggregate, pea gravel with a maximum size of ⅜ inch. The water-cement ratio, including the moisture held by the sand, was about 6 gallons per bag of cement. Calcium chloride was added to accelerate hardening.

Test equipment

The panels were bolted to the base of the test stand (Fig. 3) as they would be on a foundation wall. A cantilever load, approximating that actually applied to a self-anchored panel under wind load, was applied at the top of the panel with a hydraulic cylinder. A pressure transducer, employing electric resistance strain gages, was used to measure the force exerted by the hydraulic cylinder. Panel deflections were measured with a plumb bob suspended from the top of the panel over a scale mounted on the test-stand base.

Summary of Load Tests

	Panel I	Panel II
Deflection at design load (in.)	0 20	0 10
Deflection at 2 × design load (in.)	1 10[a]	0 40
Max. load (lb.)	590	800
Max. moment at base (in.-lb.)	56,000	76,000
Ratio: Max. load / Design load	2 8	3 8

[a] After cracking.

These readings gave the horizontal movement of the top of the panel relative to its base.

Load test of Panel I

Panel I was tested at the age of 13 days. The concrete strength was more than 4,000 p.s.i.

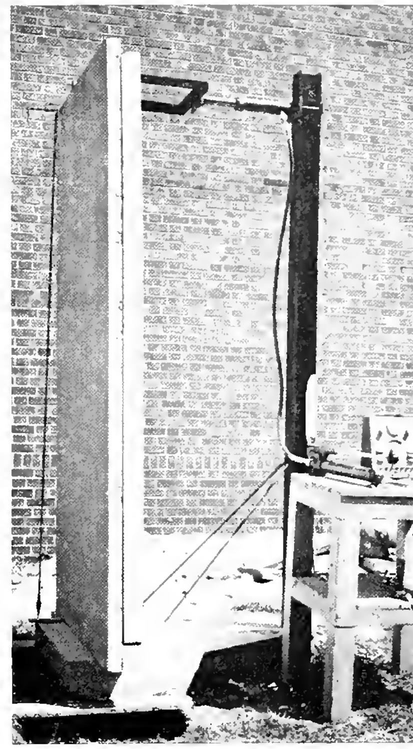
The panel was first tested with the inner face (insulated side) in tension. First the load was applied and removed in three consecutive cycles, with the maximum load equal to the design load. Each time the panel deflected about 0.15 inch at design load and immediately recovered all deflection when the load was removed. Then the panel was loaded to 1.5 × design load, with no sign of failure. After this loading the panel again recovered all deflection.

Next the panel was tested with the outer face in tension. Again the panel was loaded to design load for three cycles. The deflections were about 0.2 inch and were immediately recovered upon unloading. Finally the load was increased until it was apparent that the steel reinforcement was yielding. At a little over twice design load, the panel cracked suddenly and thereafter deflected at an increasing rate.

No crushing of concrete was observed on the compression edge of the panel base, and no cracks or other signs of failure of the base were noted.

Load test of Panel II

Panel II was tested at the age of 14 days. The concrete strength was over 4,000 p.s.i. The panel was tested with the inner face in tension. As in previous tests, the design load was applied and removed three



Panels were bolted to a test stand, and a load was applied to the top. (Fig. 3)

times, and then the panel was loaded to failure. At design load the deflection was only 0.1 inch, which was completely recovered upon unloading.

At a load of about 2.3 × design load a crack appeared in the base, leading from a lower corner of one of the access holes in the inner face. As the load increased, the base cracked further. At about 3.2 × design load, horizontal cracks, such as would be expected for flexure, appeared in the tension face. There was no crushing of concrete on the compression edge.

For more information

From these tests it was concluded that the panel designs satisfy the structural requirements for self-anchored panels. Local builders should find them well suited to many buildings. For more information, write to the Agricultural Engineering Department, University of Illinois, for "Casting and Erecting Self-Anchored, Continuously Insulated Concrete Wall Panels."

Kissing Bugs Infest Illinois Houses

Because their bite can cause serious illness, kissing bugs are a potential threat to public health; fortunately, however, they are not yet widespread in this state

J. A. PORTER, JR.

KISSING BUGS, known also as giant bed bugs or cone nose bugs, are living with and feeding on man in Illinois. Their scientific name is *Triatoma sanguisuga.*

Their presence in Illinois homes is a potential threat to public health. A small percentage of people bitten by these bugs become so hypersensitized that they suffer serious illness.

Even more important, *Triatoma sanguisuga* is capable of spreading Chagas' disease. This disease has been conservatively estimated by a study group of the World Health Organization to affect 7 million people in South America. Many people suffering from this disease have chronic heart disorders. In Brazil, where the disease is particularly virulent, it causes death in about one out of ten cases.

A large subfamily

Triatoma sanguisuga is one of approximately 100 species that compose the subfamily Triatominae. All species feed on blood. Most of them are found only in the Americas. Each species has its own habitat, feeding on the mammals which share that habitat.

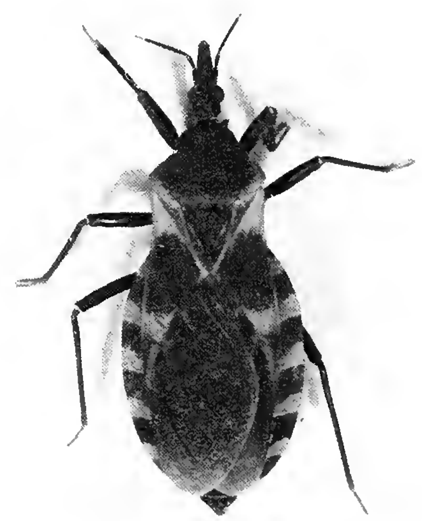
A few species, including *T. sanguisuga,* have become domesticated and have adopted man as their primary source of blood. *T. sanguisuga* is the only domesticated species in the United States, although individuals of other species in this country will feed on man when he invades their habitat.

As far back as 1855, J. LeConte accompanied his original description of the insect with the following words, "This insect . . . is remarkable . . . for sucking blood of mammals, particularly of children. I have known its bite followed by very serious consequences, the patient not recovering from its effects for nearly a year."

The insect was first reported in Illinois by B. D. Walsh and C. V. Riley, in 1868. They stated that it was found in southern Illinois and must also occur as far north as Adams county, since they had seen it in a collection of insects made at Quincy and exhibited at the State Fair in 1868. They wrote, ". . . It insinuates itself into beds, . . . it sucks human blood at first hand."

T. sanguisuga is found throughout the southeastern states, as far west as Texas, Oklahoma, and Kansas, and as far north as Missouri, Illinois, Indiana, Ohio, and New Jersey.

The adults, which somewhat resemble box elder bugs and squash bugs, are 1½ inches long and are black with orange markings. They hide in crevices or dark places during the day and come out to feed at night. Their bites are painless, so people are generally unaware of their presence. Only if people become hypersensitized and ill do they realize that the insects are in their house.



An adult kissing bug shown at almost twice its normal size of 1½ inches. The bugs are black with orange markings.

Transmission of Chagas' disease

Not many cases of Chagas' disease have been reported in this country. The disease is caused by a one-celled organism, *Trypanosoma cruzi,* that penetrates into, multiplies within, and destroys the cells of the host mammal. Cells of the heart are particularly susceptible to invasion.

When feeding, *Triatoma sanguisuga* ingests trypanosomes circulating in the blood stream of infected animals. The insects act as biological incubators, thus multiplying the number of ingested organisms many thousand-fold.

Insects transmit the infection via

J. A. Porter, Jr., previously Extension Veterinarian, has been a Graduate Fellow in the College of Veterinary Medicine, working on his Ph.D. degree in parasitology. He received his degree in February.

their feces. If feces containing infective trypanosomes contact mucous membranes or abraded skin, infection may result. The insects defecate during or soon after feeding, but the North American species are slower to defecate than their South American relatives. This probably accounts for the low incidence of the disease in man in this country.

Animals can contract the infection by eating infected insects or mammals. This means of transmission does not depend on the time of defecation, so that the rate of infection in animals is as high in North America as it is in South America.

T. sanguisuga has been found infected with *Trypanosoma cruzi* in Texas, Louisiana, and Alabama, but not in Illinois. Infected raccoons, opossums, skunks, and gray foxes have been found in the southeastern states, and infected raccoons have been found in Maryland. Further investigations may disclose that trypanosomes are even more widespread in *T. sanguisuga* and woodland animals.

Survey is begun in Illinois

The need for an investigation of *T. sanguisuga* in Illinois prompted me to initiate a survey under the auspices of the Center for Zoonoses Research, College of Veterinary Medicine. I planned not only to capture the insects and examine their feces, but also to test the blood of mammals found in the habitats occupied by the insects.

At the start, I had a very limited knowledge of the occurrence and distribution of *T. sanguisuga* in Illinois. The Illinois State Natural History Survey had four specimens — one collected at Cairo in 1905, a second at Carbondale in 1909, a third at Anna in 1909, and a fourth at Sparks Hill in 1932. All had been collected at lights.

Since reports indicated that *T. sanguisuga* was found in southern Illinois, I began my search in the vicinity of the Dixon Springs Agricultural Center, between Harrisburg and Metropolis in the extreme southern part of the state. Because I was not initially aware that the species was a domestic one, I began by investigating the woodland nests and dens of possible mammalian hosts. During the first month, only one insect was found; it was in a mouse nest in the base of a dead tree.

Discouraged, I visited Dr. J. C. Downey, Department of Entomology, Southern Illinois University. He assured me that the insect was common in southern Illinois, since he had seen several in insect collections made by members of his entomology classes. Because the insects had been collected at lights, and also because the exceptionally cold weather of the previous winter had decreased the number of insects overwintering in rural areas, he advised me to search at night around lighted areas in towns. Both his secretary and a graduate student told me that they had seen the insects in their living quarters.

Guided by this information, I transferred my activities from the countryside to the city and changed my working hours from day to night. My efforts were nearly as fruitless as before. Only two *T. sanguisuga* were captured, both in the older part of the Metropolis business section.

The work would probably have been abandoned if I had not heard from the Illinois State Natural History Survey. They had received for identification a *T. sanguisuga* from an infested house in Mt. Vernon. When I visited the house I met a very distraught lady. Her mother had been under the care of a physician for two weeks because of hypersensitivity to the bites of insects. The lady knew that the insects were feeding on other members of the family as they slept — she was spending sleepless nights as a consequence.

Several infestations found

Infestations of *T. sanguisuga* were found not only in that house, but in at least four others in the neighboring area. Undoubtedly, many more houses were also infested, but people either didn't realize that the insects were living with and feeding on them, or else they didn't recognize the insects.

Subsequently, Dr. T. E. Musselman, a biologist in Quincy, wrote that the insects had infested a house in that city. Investigation disclosed that the man of the house had been under a doctor's care because of hypersensitization to insect bites. The ensuing search for the cause of his condition led to the discovery of *T. sanguisuga*, which Dr. Musselman identified. Dr. Musselman also informed me that he had seen one of the insects a few blocks from the infested house in broad daylight. His evidence confirmed the 1868 report that the insects were found as far north as Quincy, but this was only the second time in a hundred years that they had been recognized there.

People with infested houses, as well as entomologists, cooperated in capturing insects and sending them to me for examination. All but three of 25 sent in were collected in urban areas. The feces of all were negative for *Trypanosoma cruzi*. In addition, I tested over 100 mammals from southern Illinois. They also were negative. These results cannot be considered conclusive, however, since too few were examined and tested.

Send information

Hundreds and probably thousands of houses in Illinois are infested with *T. sanguisuga*. If you see insects like the one in the picture, it is requested that you capture them and either ask a local entomologist to identify them or send them to the Illinois State Natural History Survey, Urbana, for identification. If an insect is identified locally as *T. sanguisuga*, the Parasitology Division, College of Veterinary Medicine, University of Illinois, would like to be notified so further investigations can be made.

The cooperation of people living in infested houses is essential if a large number of insects are to be captured for examination. With this cooperation, the danger posed by *Triatoma sanguisuga*, the kissing bug of Illinois, can be properly evaluated.

THE HYDRAULIC SOIL-CORING MACHINE—
A New Method of Sampling Illinois Soils

E. C. A. RUNGE

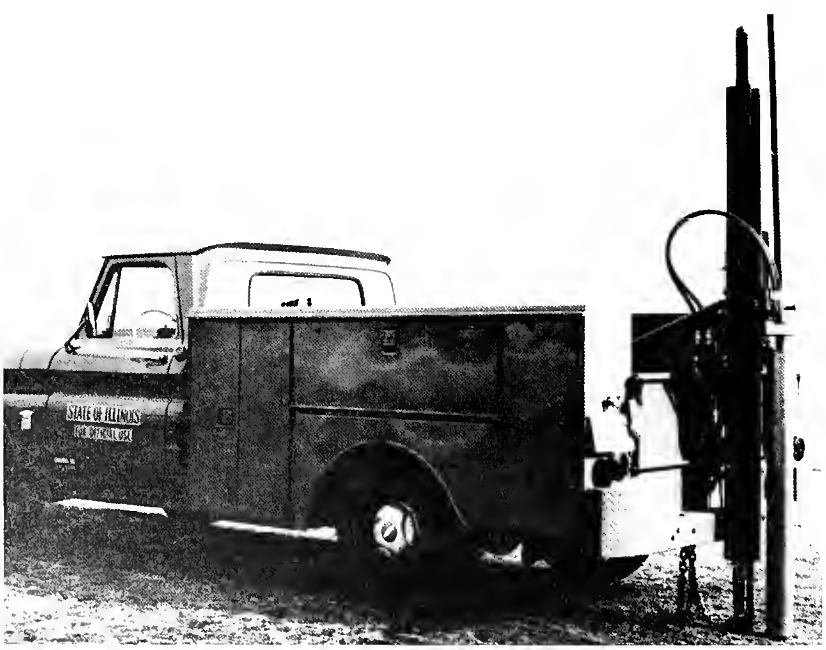
In an age when man is shooting for the moon and the center of the earth at the same time, he still has problems in sampling soils. For nearly 100 years pedologists (soil scientists) have been sampling soils from roadcuts or dug soil pits, or using small hand-operated soil augers and probes to obtain samples. Although these sampling methods will continue to be used, they do have serious limitations. Roadcuts are usually carved through the wrong soil at the wrong place; dug soil pits, though excellent, are very time-consuming; and hand-operated augers and probes work well in routine soil mapping but provide soil samples that are inadequate for many studies.

The hydraulic soil-coring machine recently purchased by the Agronomy Department is not a panacea for all problems of soil sampling. It does, however, provide soil samples adequate for most soil investigations with minimum time and effort. The samples are cores of soil up to 4 feet long (the length of the sampling tubes). Soil deeper than 4 feet can be sampled by taking additional 4-foot cores. The machine is gaining rapid acceptance as a result of the following advantages:

- Soils can be sampled in a matter of minutes rather than hours. The only requirement is that the sampling site be accessible by truck.
- Samples large enough for most soil investigations can be taken from small research plots with only a minor disturbance of the plot.
- The soil cores are undisturbed samples, the only disturbance being at the edge of the core where it was cut from the adjacent soil.
- If a soil core proves undesirable upon closer inspection, a new core can be obtained from another site with little loss of time.

The soil-coring machine is being used in the research, teaching, and extension programs of the Agronomy Department. When available, it is also being used by other departments. In the first 4 months of operation 21 different people used the machine to sample approximately 770 soil sites.

E. C. A. Runge, who appears in picture at lower right, is Assistant Professor of Soil Classification Extension and Research.



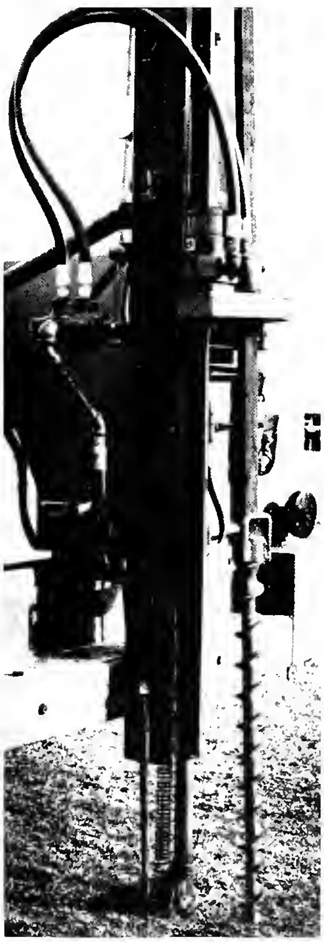
The hydraulic soil-coring machine is mounted on a ¾-ton truck. Soil-coring tubes, related equipment, and tools are kept in the compartments of the utility truck body. The tower folds down to an angle of approximately 30 degrees during transport.

The sampling tube is pushed into and pulled from the soil by a hydraulic cylinder. Tubes are available in five different diameters.

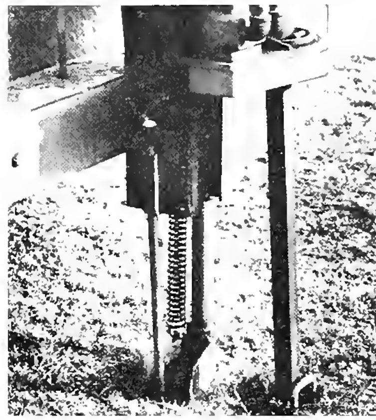
s are about ½ inch smaller in diameter than the tubes, permit-
l of soil cores. The cores range from 1.3 to 4 inches in diameter.
h cores are taken when a large sample or close observation of the

allows the scientist to follow
ion. Note that soil has not
inside the tube.

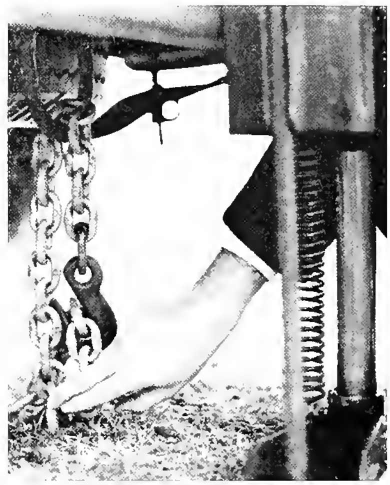
B. W. Ray (left) and H. L.
e a 24-foot core of soil. The
eft are the upper 20 feet and
ght is the lower 4 feet of the
r 19 feet is loess; the lower
glacial till. Soil monoliths
m cores such as these in only
time previously required.



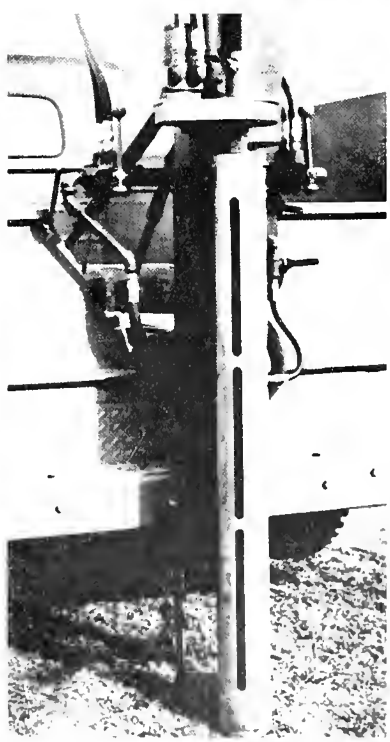
A 4-foot flight auger (actually a discarded coal stoker auger) anchors the truck. Here the auger is halfway in the ground. To turn the auger all the way into the ground takes 25 revolutions of the hydraulic motor (the round device with the two hydraulic tubes).



The anchor is now completely in the ground. As far as is known, Illinois soil scientists are the only people using a power anchoring device with a hydraulic soil-coring machine. Other states with such a machine add weight to the truck. This requires a large, rough-riding truck which is less maneuverable and more costly than the one used here.



After the anchor has been set, the truck is backed up about 18 inches and the truck frame is chained to the anchor. The anchor holds the truck while the soil-coring tube is pushed into the ground, and the hydraulically operated foot supports the truck while the tube is pulled from the soil.



The hydraulic soil-coring machine has been anchored and is ready to take a 4-inch soil core. With this anchoring system, large cores can be taken even when the soil is dry. There are two main hydraulic controls on the soil-coring machine. The one on the left controls the rotation of the tube or auger; the one on the right, the up and down movement. By means of two other valves the right control also operates the foot and the hydraulic cylinder which erects the tower.

Breeding Tomato Varieties With Increased RESISTANCE TO FRUIT CRACKING

A. E. THOMPSON

FRUIT CRACKING has always been a serious problem for tomato producers. The cracks may be invaded by decay-causing microorganisms. Or the fruits may become contaminated when fruit flies deposit their eggs in the cracks. Even when there is little or no decay, cracked fruits often mean large trimming losses.

Although no variety is completely resistant to cracking, some new varieties are relatively resistant. Since these new varieties have been in use, the yield of tomatoes for processing has nearly doubled in Illinois. Even so, large numbers of tomatoes still crack in the field.

The problem of cracking has been accentuated by the development of mechanical tomato harvesters. A combination of high crack resistance and firmness is essential if fruits are to be harvested mechanically.

Problems of measuring resistance

It has been known for some time that heritable differences in crack resistance exist between varieties and strains of tomatoes. One of the big problems in measuring and selecting for crack resistance, however, has been to eliminate or minimize the variability caused by environment. Variations in soil moisture and rainfall are the factors most closely associated with cracking.

Numerous methods have been devised to aid in testing for resistance. These include heavy applications of irrigation water, soaking fruits in water, and measuring the strength of the skin of the fruit with various devices.

Vacuum provides answer

In 1956 experiments were being conducted in the Horticulture Department to determine if consistent cracking could be induced by soaking detached fruits at controlled temperatures in a water bath. It was noted that very little cracking occurred, and that a stream of air bubbles came out of the stem end if a fruit was gently squeezed while immersed in water. Since the skin of the tomato is relatively impervious to water and air, nearly all the exchange must occur through the vascular elements of the stem. Undoubtedly air bubbles were blocking the entrance of water into the fruits, thus preventing cracking.

When a partial vacuum was applied to fruits immersed in water, this air was removed. Upon release of the vacuum, the fruits absorbed water and cracked in both radial and concentric patterns similar to those observed in the field (Fig. 1). The vacuum-immersion method was subsequently refined by Dr. R. W. Hepler so that the experimenter could closely control the level of stress on the fruits.

Testing procedures

In general, the vacuum-immersion method of testing is as follows: Fruits are selected at incipient color, marked for identification with a black felt marking pen; evacuated at specified vacuums (usually 4, 7, or 10 inches of mercury); and immersed in water maintained at 70° F. for 3 hours (Fig. 2).

The cracks on the fruits are classified as radial or concentric. The length of cracks may be estimated visually or determined with a map measure. Seed is saved from fruits with the least cracking.

Many genetic factors

Research utilizing the new vacuum-immersion method has demonstrated that certain types of crack resistance are conditioned by a large number of genetic factors, each having a relatively small individual effect. For increased resistance to cracking, the highest possible number of additive factors for resistance must be concentrated into one strain.

Conceivably, this concentration could be obtained by crossing unrelated crack-resistant strains. If a portion of the resistance in the unrelated lines is attributable to different genetic factors, and if recombination of these factors can be obtained after crossing, it should be possible to select out individuals more resistant than either parent.

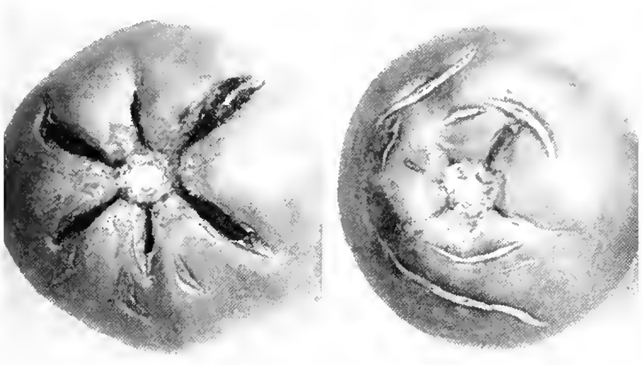
Two lines selected

To test the hypothesis of improvement through recombination and selection, two unrelated lines, Cornell University 59-400 and Campbell Soup Company Kc109, were selected. Both lines had been extensively tested for crack resistance with the vacuum-immersion method, and had proved superior to most commercial varieties.

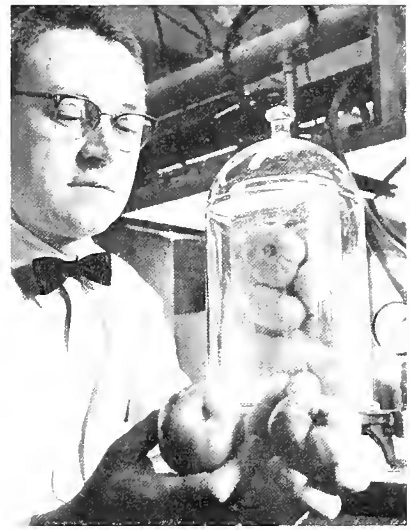
Crosses were made between the two varieties. The F_1 and the F_2 segregating generations were grown and tested in 1962 along with the two parental varieties and a susceptible variety, Garden State.

Seed was saved from all of the 240 F_2 plants, and the F_3 progenies from each were grown in 1963. In addition, a selected F_3 population was grown from seed from 42 F_2's whose fruits showed no cracking. Progenies were also grown from 30 plants of each of the three control varieties. Fruit from 10 plants in each line were tested. Data for total cracking are presented in Figure 3.

It is clearly evident from Figure 3 that genetic factors for crack resistance have been recombined. The unselected F_3 progenies exceeded the parental population on both ends of the distribution. This means that new



Radial and concentric fruit cracking. (Fig. 1)



A. E. Thompson, Professor of Plant Genetics, Horticulture Department, with the vacuum-immersion chamber. Tomatoes are evacuated at specific vacuums in this chamber, after which they are held in water for 3 hours. They are then checked for type and extent of cracking. (Fig. 2)

combinations of genetic factors have resulted in types with both higher and lower resistance than that found in the parents. The F_3 progeny from the 42 selected F_2 plants showed a shift toward higher resistance than the unselected F_3.

Further tests

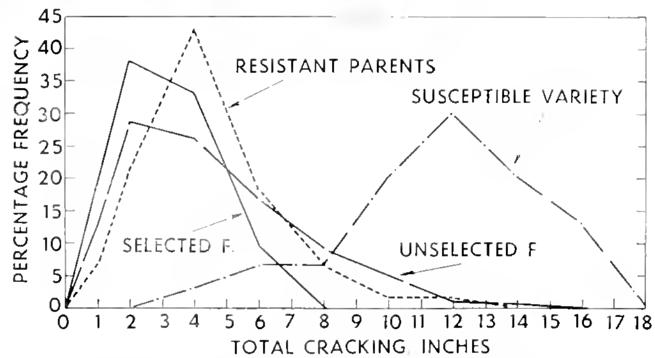
To further test if the selection was effective, seed was saved from some of the superior F_3's. In a replicated experiment in 1964, the performance of four of the most resistant selections was compared with that of three resistant varieties and of two susceptible varieties. The resistant varieties included the two parental lines, 59-400 and Kc109, and the standard resistant variety, Campbell 146. Rutgers and Garden State were the two susceptible varieties.

Samples were tested at three different levels of vacuum — 4, 7, and 10 inches of mercury (Hg). In addition, two samples were measured in the field to determine the extent of cracking (Fig. 4).

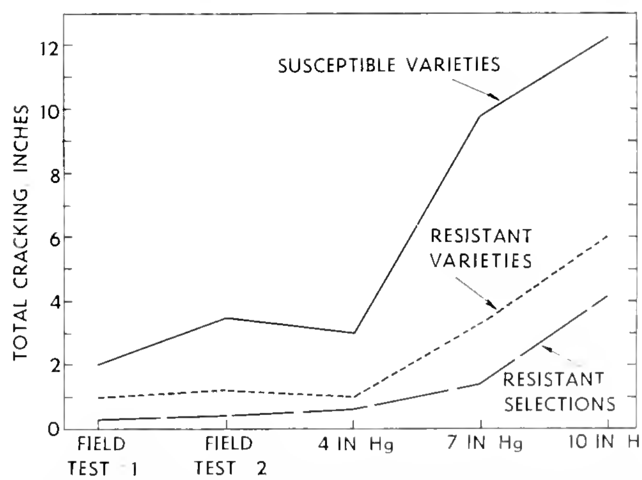
The growing and harvest season was abnormally dry. No measurable rain fell from July 19 to August 17. All samples except the second field sample were tested and measured during the dry period. Rains totaling about 2¼ inches occurred between August 18 and 25. The second field sample was measured about a week after the rains. The effects of the rains can be seen in Figure 4 when the two field samples are compared. The 4-inch vacuum gave essentially the same results as the second field test.

At all levels of testing, the resistant selections were more highly resistant to cracking than the parental lines from which they descended. Differences between the means of the three groups were statistically significant. Such differences can be expected to persist in future generations.

It was concluded that selection for the highest levels of crack resistance can be most efficiently accomplished at the highest vacuum. Research is being continued to determine if additional generations of selection at the high vacuum will increase resistance to cracking. A whole new series of crosses is currently being made between 15 unrelated varieties and strains with varying crack resistance. By applying the selection procedures



Fruit cracking of two resistant varieties, their selected and unselected F_3 progenies, and one susceptible variety. (Fig. 3)



Fruit cracking in two field samplings and in tests at three levels of vacuum: averages of four resistant selections, three resistant varieties, and two susceptible varieties. (Fig. 4)

outlined above, it may be possible to identify entirely new recombinations of genetic characters. Segregates may be isolated that would be immune to cracking in the field under normal environmental conditions.

High Energy Level in Ration May Prevent MILK FEVER IN DAIRY COWS

K. A. KENDALL, K. E. HARSHBARGER, R. L. HAYS, and E. E. ORMISTON

EVIDENCE is increasing that an effective way of preventing milk fever in a dairy cow is to feed her extra grain before she calves.

In earlier studies at the University, the daily rate of grain feeding for milk-fever suspects was increased from 0.5 percent to 1 percent of body weight during the last 3 weeks of the dry period. The cows' levels of both serum calcium and inorganic phosphorus were increased, and none of the cows developed milk fever. With these encouraging results, further study seemed justified.

Three-way approach

A three-way approach was followed in studying the relationship between the parturient cow's energy requirements and her mineral status. Part of the approach was to increase the level of grain in a cow's ration. In addition, we studied the effects of metabolic stimulants and depressants.

Three high-producing cows were included in the study. Cow 1680, a Jersey, and cow 1532, a Holstein, had previously had milk fever and were considered suspects. Cow 1839, a Holstein, had not developed milk fever previously, although her serum calcium and inorganic phosphorus levels had been abnormally low.

Before calving in 1962, cows 1680 and 1532 were fed a control ration, consisting of grain at the daily rate of 0.5 percent of body weight, plus alfalfa with or without corn silage free choice.

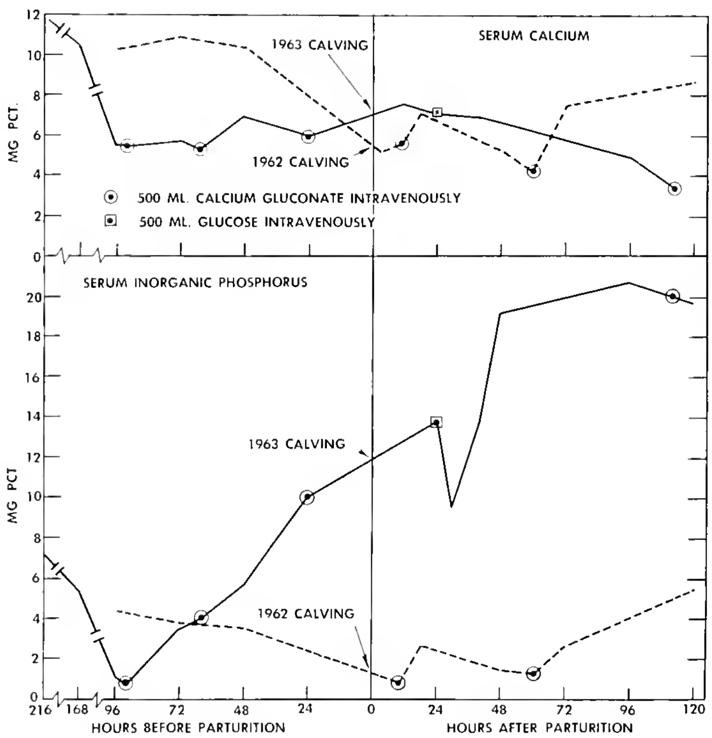
For 10 days prior to her 1963 or seventh calving, cow 1532 was fed grain at a daily rate of 0.75 percent of body weight. For 5 weeks before her eighth calving, she was fed alfalfa hay free choice, plus a mixture of 94 percent ground shelled corn, 5 percent molasses, and 1 percent trace salt, at the daily rate of 1 percent of body weight.

Cow 1680 received the same ration in 1963 as in 1962. In addition she received a metabolic stimulant for 5 consecutive days, beginning 9 days before calving. The stimulant was 20 grams of iodinated casein in capsule form.

Cow 1839 was fed the same ration in 1963 and 1964 as previously described, with the addition of a metabolic depressant in 1964. The depressant (17.5 grams of thiouracil in capsule form) was fed daily, starting on the seventeenth day before calving.

Jugular blood samples from all three cows were taken at frequent intervals before and after calving. Calcium levels in the serum were determined flame-photometrically; inorganic phosphorus levels, by the Fiske and Subbarow method.[1]

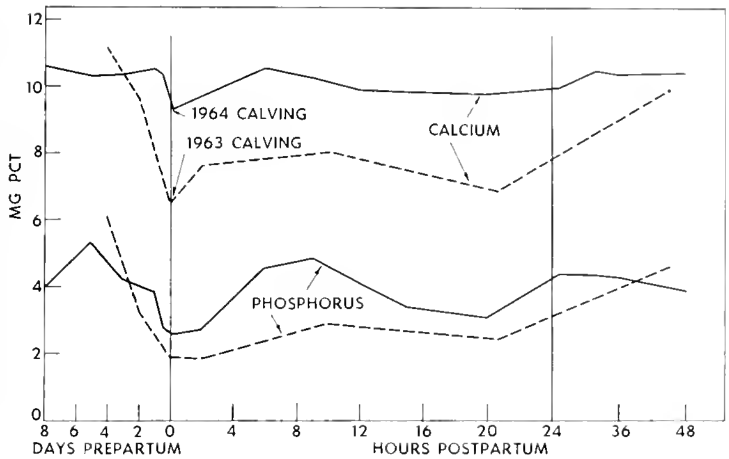
Normal levels of serum calcium are 10 to 11 milligrams per 100 milliliters, and of inorganic phosphorus, 4 to 5 milligrams per 100 milliliters. Milk fever symptoms often develop when serum calcium levels drop to 6 milligrams per 100 milliliters and



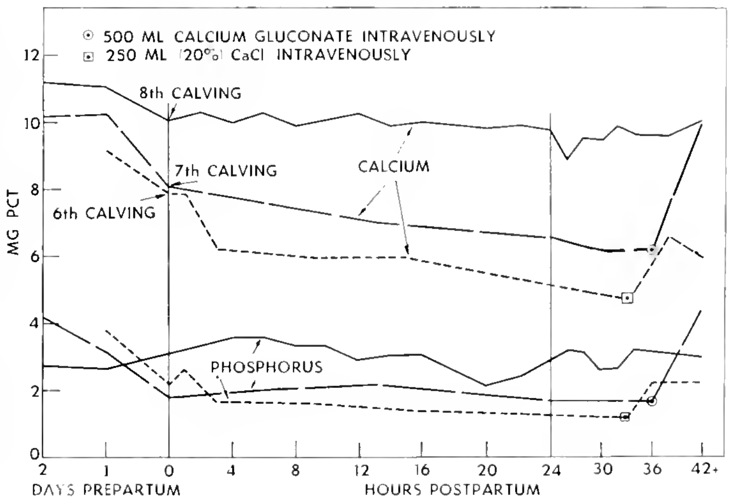
Blood serum calcium and inorganic phosphorus levels in cow 1680 when the control ration was fed (1962 calving) and when iodinated casein was fed as well (1963 calving). The iodinated casein was started 9 days before calving at the rate of 20 grams a day. The cow died on the fifth day after calving in 1963. (Fig. 1)

K. A. Kendall, Professor of Dairy Science; K. E. Harshbarger, Professor of Nutrition; R. L. Hays, Associate Professor of Physiology; and E. E. Ormiston, Professor of Dairy Husbandry, are all in the Dairy Science Department.

[1] Fiske, C. H., and Subbarow, Y. The colorimetric determination of phosphorus. J. Biol. Chem. 66:375. 1925.



ood serum calcium id inorganic phosorus levels in cow 39 when she reved the control ran (1963) and when e received 17.5 ams of thiouracil ily for the last 17 ys of gestation 964). The consertion of energy that sulted from feeding ouracil may have counted for the gher mineral levels 1964. This cow did t develop milk fever her year. (Fig. 2)



rum mineral levels cow 1532 when she is fed grain at three fferent rates. Before her sixth (1962) lving, the daily ain rate was 0.5 percent of body weight. is was boosted to 75 percent for 10 ys before her sevth calving and to 0 percent for 5 eeks before her ghth calving. She veloped milk fever hen fed at the 0.5-id 0.75-percent rates it not at the 1-percent rate. (Fig. 3)

phosphorus levels are 1 to 2 milligrams per 100 milliliters, or when the serum phosphorus to calcium ratio approaches 1:4.

Effects of iodinated casein

Figure 1 shows the serum calcium and inorganic phosphorus levels of cow 1680 before and after her 1962 calving, when she was fed the control ration; and her 1963 calving, when she received iodinated casein.

When fed the control ration, she developed milk fever a few hours after calving. When fed the iodinated casein, she developed milk fever 96 hours before calving. Both years the calcium levels ranged between 4 and 6 milligrams per 100 milliliters just before calcium treatment was administered.

Serum phosphorus levels varied widely when the cow was fed iodinated casein. About 96 hours before calving, the serum phosphorus had declined to about 0.6 milligrams per 100 milliliters. After treatment with calcium gluconate it rose precipitously to 14 milligrams per 100 milliliters. At 24-hour postpartum, phosphorus declined markedly following a glucose injection and rose again to 20.8 milligrams per 100 milliliters at 72 hours after calving.

The cow showed typical symptoms of milk fever and died 5 days after calving. Iodinated casein has long been known to stimulate metabolism, increasing the body's demands for energy. The trends in serum calcium and phosphorus levels in this cow may have resulted from tissue energy depletion.

Effects of thiouracil

Cow 1839 did not develop milk fever either when she was fed the control ration or when she was fed thiouracil. When she received thiouracil, both calcium and phosphorus levels were substantially higher during the 24-hour postpartum period than they had been after the previous calving (Fig. 2).

Comparing these observations with the results obtained from feeding iodinated casein, one may ask whether higher levels of body energy helped to maintain higher serum levels. Feeding a metabolic depressant was one way of conserving body energy; another was to feed more grain.

Effects of increased grain

Figure 3 shows the response of cow 1532 to three different levels of grain feeding during the dry periods preceding her sixth, seventh, and eighth calvings. Levels of both serum calcium and inorganic phosphorus rose as the grain feeding rate was increased from 0.5 percent of body weight to 0.75 percent, and then to 1 percent. Cow 1532 developed milk fever, requiring calcium therapy, at her sixth and seventh calvings, but did not develop it at her eighth calving, when she was fed grain at the 1-percent rate for 5 weeks before calving.

Early findings supported

These results support the preliminary findings and provide further evidence that feeding grain at the daily rate of 1 percent of body weight will prevent or reduce the incidence of milk fever in the dairy cow.

A report of the preliminary findings may be found in two articles by Kendall and Harshbarger: "The responses of the paretic suspect to varied prepartum grain feeding levels" (*Illinois Veterinarian*, Spring, 1964), and "The effects of prepartum feeding rate upon serum mineral levels in paretic suspect cows" (*Journal of Animal Science*, November, 1963).

Production of Sterile Milk and Cream For Shipment to Tropical Climates

H. K. WILSON and E. O. HERREID

Stories from faraway locations of our armed forces have told us that one thing the boys miss most is fresh whole milk. This need has stimulated research to produce sterile milk and cream for shipment to any climate without refrigeration and without loss of fresh flavor. The desire to help undernourished nations, which are invariably lacking good dairy products, has added further stimulus to this search for milk and cream with extended keeping quality.

Fresh concentrated milk palatable

Research in the Department of Food Science has shown that sterilizing concentrated milk at 300° to 305° F. for less than a second has resulted in a product with much better flavor and color than conventional evaporated milk which has been held at 240° to 250° F. for 2 to 15 minutes. After fresh concentrated milk sterilized by this new method has been diluted back to normal milk composition, many people cannot distinguish between it and fresh pasteurized milk. A few people prefer the sterilized milk.

Storage problems

Unfortunately, changes in flavor, body, and texture cause problems when sterile products are stored a long time in tropical climates.

One problem, thickening or gelling, can be controlled by adding 0.05 to 0.1 percent of sodium polyphosphate before sterilization. This substance is not harmful: on the contrary, there is reason to believe that it may improve retention of phosphate, which is essential for bone and muscle structure in man and animals. Excessive amounts of sodium polyphosphate, however, may give milk a salty taste and cause proteins to settle at the bottom of the cans, forming a gelatinous layer.

Problems of grainy texture can be avoided by properly controlling time and temperature of heating and by using good quality raw milk. Graininess is due to particles that are relatively large, even though they are still microscopic in size. The growth of these large particles in relation to processing steps has been studied by measuring the rate of their movement in an ultracentrifuge at forces of 1,500 to 10,000 times that of gravity.

Findings in the ultracentrifuge regarding size changes of particles were confirmed by microscopic examination. Contrary to popular belief, most of the casein particles in raw milk can be seen in a research microscope with the proper lighting. These particles are normally 0.1 micron (0.000004 inch) in diameter or larger. Some casein particles are only one-third this size and are probably not visible through a microscope, but they make up only a small part of the total casein.

During the processing of concentrated milk, the protein particles can be expected to increase in size or to combine with fat to form larger particles. With proper temperature and quality controls, the maximum size of the protein particles is 0.7 micron (0.00003 inch) and of the protein-fat particles, 2 microns. The grainy sensation does not develop until the particles are more than 10 microns (0.0004 inch) in diameter.

Although the problems of graininess, sedimentation, and gelatin can be controlled, little progress has been made in the control of color or flavor when the products are held above 100° F. for extended periods. Three or four weeks of high storage temperatures will cause the sterile concentrated milk to darken and develop a strong caramel flavor.

A more palatable product

In geographical areas where high temperatures cannot be avoided, a more palatable product than sterile concentrated milk can be made by recombining nonfat dry milk solids with water and sterile cream.

Nonfat dry milk powder packed in moisture-proof containers will deteriorate in flavor, but not so much as concentrated milk. Sterile cream does not contain as many nonfat solids as concentrated milk and so does not develop a brown color and caramel flavor to the same degree. It is susceptible to other flavor defects, but these are not so important in concentrated milks. Probably the most serious defect of sterile cream is the tallowy or oxidized flavor. The nature of this flavor has been studied extensively and definite progress has been made in its control, as well as in the control of other defects.

Under present conditions, the nonfat dry milk and sterile cream are favored not only by their ability to produce a palatable product under adverse conditions, but also by an advantage in shipping weight. To make 1,000 pounds of beverage milk requires 333 pounds of concentrated milk, as compared with only 190 pounds of nonfat dry milk solids and sterile cream. There would also be further savings in freight due to the type of containers used.

Quality important

Whatever type of sterile milk product is used, high-quality raw milk is just as important as it is for the production of fresh pasteurized whole milk or ice cream. This fact has been confirmed repeatedly by laboratory tests and experiments.

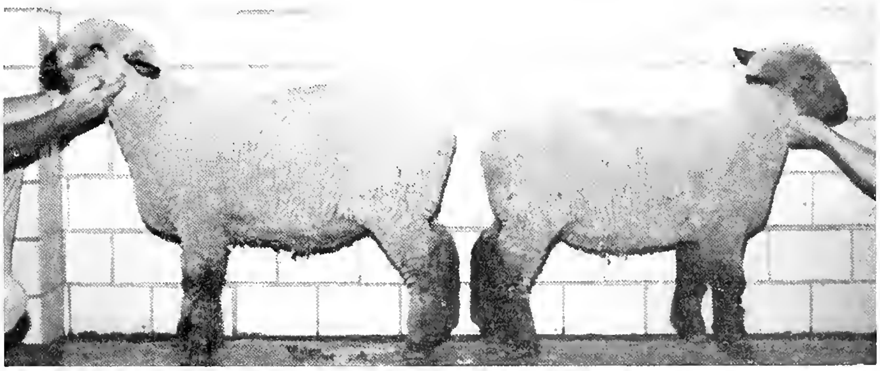
H. K. Wilson is Assistant Professor of Dairy Technology and E. O. Herreid is Professor of Dairy Technology, both in the Food Science Department.

ALTERING THE DIGESTIVE PROCESSES OF LAMBS

M. R. KARR, U. S. GARRIGUS, E. E. HATFIELD, and R. P. LINK

SHEEP and other ruminants have an advantage over simple-stomached animals in being able to utilize fibrous feeds more efficiently. This is due to the symbiotic action of rumen microflora which converts the feeds into simpler fatty acids and other substances.

With an all-concentrate ration, however, the rumen's action is less efficient than the direct digestive processes of the simple-stomached animal. This raises the question as to whether we can eliminate the intermediate step of rumination when an all-concentrate ration is fed.



After 110 days of experimentation, lambs receiving high levels of antibiotics and sulfa-drug (left) were markedly larger than the control lambs (right).

Usual rumen development

It is well known that the rumen is not fully developed at birth and that the digestive processes of the very young ruminant are more like those of a simple-stomached animal than a mature ruminant. During the first few weeks of life the rumen mucosa, which is relatively smooth at birth, becomes highly papillated. The papillary development has been related to intake of dry feed and more specifically to propionic and butyric acids, end-products of ruminal fermentation.

Hypothesis tested

If rumen papillary development depends upon fermentation within the rumen, it should be possible to prevent rumen development by inhibiting ruminal microorganisms. This hypothesis was tested in a preliminary study of 2-week-old lambs.

All lambs received a concentrate ration adequate in amino acids and vitamins, but low in crude fiber (suitable for baby pigs). In an attempt to inhibit growth of rumen microorganisms, test lambs received 1,840 milligrams of antibiotics and sulfa-drug per pound of diet. Control lambs received 10 milligrams of antibiotic per pound of diet (a normal level).

Good gains on test diet

During the first 42 days of the experiment the lambs had access only to their mother's milk and their assigned creep diet. From weaning until slaughter the lambs had access to the creep diet only.

As shown by the following figures, both groups made relatively efficient gains for ruminants on a finishing-for-slaughter program, but the test (high-drug) lambs did much better than the control lambs:

	Control lambs	*Test lambs*
	pounds	
First 42 days		
Av. daily gain	0.50	0.75
Feed per lb. of liveweight gain[a]	0.90	0.73
Weaning to slaughter		
Av. daily gain	0.52	0.75
Feed per lb. of liveweight gain	4.1	3.7

([a] In addition to mothers' milk.)

Test lambs had an average daily feed intake of 1.69 pounds; control lambs, 1.32 pounds. Because of the test lambs' more rapid gain in weight, however, their feed intake represented a smaller percentage of body weight (3.1 percent) than did the control lambs' intake (3.3 percent).

Obviously the lambs fed high levels of antibiotics and sulfa-drug made more efficient use of the ration. This may be partly explained by some observations made during the course of the study.

The papillae or protuberances on the rumens of the control lambs were denser and shorter than those of the test lambs. The high-drug treatment evidently changed the fermentation pattern: Rumen fluid from the test lambs had a significantly lower concentration of total volatile fatty acids (64 micromoles per milliliter vs. 96 for the control lambs), and of propionic acid (36 percent vs. 46 percent). Valeric acid content, however, was higher in the test lambs (8.1 percent vs. 3.3 percent).

Protozoa were not observed in the rumen fluid of either group. A normal drop in blood glucose was observed in both groups during the first 6 weeks of experiment.

What is the significance?

Since carcasses of treated animals are not now approved for human consumption, these studies do not yet have a practical application. The data do indicate that the antibiotics and sulfa-drug inhibited and altered ruminal fermentation. This observation encourages further basic studies of rumen activity.

M. R. Karr was formerly Assistant in Animal Science; U. S. Garrigus is Professor and E. E. Hatfield, Associate Professor of Animal Science; R. P. Link is Professor of Veterinary Research.

RESEARCH IN BRIEF

The Role Played by Phytoalexins in the Disease Resistance of Soybeans

Plants growing in nature are resistant to most of the microorganisms that surround them. Many of these organisms can penetrate plant tissue. Once inside the plant, however, their growth is stopped and they are incapable of causing disease.

Recent research indicates that phytoalexins (toxins formed by a plant in response to an invading organism) may be responsible for the disease resistance of some species. There is also evidence that plants are susceptible to certain diseases either because the pathogens do not induce enough phytoalexin to inhibit their development or because pathogens are more tolerant of phytoalexins than are nonpathogenic microorganisms.

The development of soybean varieties highly resistant to Phytophthora root and stem rot has provided excellent material for studying the nature of disease resistance. Resistance to Phytophthora is controlled by a single dominant gene, and varieties differing in this gene, such as Harasoy (susceptible) and Harasoy 63 (resistant), are available.

When Harasoy 63 plants are inoculated with the Phytophthora that causes root and stem rot, the plants produce a phytoalexin and the fungus ceases to develop. Harasoy plants inoculated with this organism are quickly killed, and a phytoalexin has not been detected. Both Harasoy and Harasoy 63 produce a phytoalexin when they are inoculated with a species of Phytophthora which does not produce a disease of soybeans. Thus, there is evidence that a phytoalexin is involved in disease resistance of soybeans. Susceptibility of Harasoy to the Phytophthora that causes root and stem rot is apparently due to the inability of this variety to produce the phytoalexin, or to produce it in sufficient quantity to inhibit the fungus.

Research is underway to identify the phytoalexin and to determine the substances that stimulate its production. Work is also in progress to determine the importance of phytoalexins in the resistance or susceptibility of soybeans to other diseases. — *J. W. Gerdemann and J. D. Paxton*

Persimmon Makes Poor Fence Posts Even When Treated With a Preservative

Persimmon (*Diospyros virginiana*) grows singly or in clusters, and commercially available stands are few within its natural range. Farmers have always considered persimmon to be a weed tree, and few attempts have been made to utilize the wood for products other than fuelwood.

In March, 1956, the Department of Forestry set 21 treated and 10 untreated persimmon fence posts in a test line at the Dixon Springs Research Center near Simpson. The treated posts had been cold-soaked in a 5-percent solution of pentachlorophenol in No. 2 fuel oil for 48 hours.

Test borings made on the treated posts showed that the maximum penetration of the preservative was only 0.2 inch. The cell walls of persimmon are very thick, and the passageways available for the movement of liquids between cells are minute, probably accounting for the poor penetration of the preservative.

The average absorption of preservative — 3.93 pounds per cubic foot of wood — was also low. The desirable average for fence posts treated by the cold-soaking method is about 6 pounds per cubic foot. The difficulty in obtaining satisfactory penetration of the preservative may have accounted for the low absorption values.

Untreated posts had an average service life of 31 months; treated posts, 75 months. Although the treated posts lasted more than twice as long as the untreated posts, a service life of slightly over 6 years is not enough to make treatment of persimmon for fence posts economically sound. — *K. R. Peterson*

Chlorination and Filtering Are a Possible Method of Managing Swine Waste

Chlorine has for many years been used as a disinfectant, flocculant, and deodorizer in the treatment of domestic sewage. The following experiment was conducted to investigate the efficiency of chlorine as a deodorizer and flocculant in the treatment of raw pig waste.

Waste that had been accumulating in the pit of a slotted-floor finishing building for one week had a COD (chemical oxygen demand) of 20,200 p.p.m. This waste was diluted with 1 part of water, and the mixture was sparged with chlorine gas at a very slow rate for about 30 minutes. The mixture was stirred continuously for at least 1 hour after the chlorine gas was applied. The mixture was then allowed to flocculate for about 12 hours before it was filtered through a 6-inch deep sand column. The effluent from the sand bed was slightly cloudy and had a faint odor of chlorine. The COD of the effluent was 2,860 p.p.m. (not corrected for chlorine content).

In actual operation it might be desirable to reuse the effluent from the sand filter. Another portion of raw waste was therefore mixed with 1 part of the effluent from the already treated waste, and the mixture was chlorinated and treated in the same way as the first sample. This procedure was repeated on four successive samples. The CODs and the volatile solids of the effluents from the sand column are shown at the top of the next page.

COD	1st cycle	2nd cycle	3rd cycle	4th cycle
Original, p.p.m. . .	10,100	11,530	12,450	12,890
Effluent, p.p.m. . .	2,860	4,700	5,580	6,700
% reduction	71.7	59.0	55.0	48.2
Volatile solids				
Original, p.p.m. . .	5,000	5,461	5,728	5,983
Effluent, p.p.m. . .	922	1,456	1,866	2,666
% reduction	81.6	73.3	67.4	55.4

Judging from these data, there seems to be an accumulation of material that is not susceptible to chlorination and flocculation, and it seems doubtful that the effluent could be reused very many times. The material that accumulates is probably small organic molecules not affected by the chlorination.

The effluent from the sand bed could be dumped into a farm lagoon, and because of the reduced organic load and the residual chlorine, the odor problem might be less than in a lagoon that receives untreated waste. The solids that accumulate on the sand bed would have to be removed periodically.

Although chlorine gas showed some promise in the treatment of diluted swine waste, it is not known whether enough chlorine gas would be released into the atmosphere to affect the pigs and become an air-pollution hazard. Possibly certain chlorinated compounds would be as effective as chlorine gas and would have the advantage of releasing less gas into the atmosphere.

A sand filter bed is under construction on the University's Moorman Swine Breeding Research Farm so that this method of fluid manure management can be field-tested. — *R. L. Irgens and D. L. Day*

Hotel and Restaurant Trade Is a Growing Market for Meat

Hotels and restaurants have provided an expanding market for meat, and this trend will likely continue. To learn more about this market, 119 Chicago hotels and restaurants were surveyed as to their meat procurement and use.

Beef was the favored meat, accounting for 59.4 percent of the estimated total weekly supply of meat. Poultry accounted for 14.8 percent; fish, 10.5 percent; and pork, 9.7 percent.

Representatives of these firms stressed their preference for a high and uniform quality of meat. While the firms thus constitute a market for high-quality beef, this beef is not necessarily Prime. Of the average weekly volume of beef used, 9.3 percent went to firms handling only Prime; 55.8 percent went to firms using both Prime and Choice. Many of the persons who were interviewed said that Prime beef was too wasty and costly and that Choice beef, besides being more economical, approached Prime closely enough to be satisfactory for their business.

The specialized meat wholesaler (meat purveyor) was the only type of supplier patronized by most of the hotels and restaurants in the study. A relatively limited number of suppliers filled most needs of all these firms. Forty-seven firms purchased beef from a single source, and 21 firms purchased all of their meat from a single supplier. (This supplier was not necessarily the same for all firms.)

When choosing sources of supply, the firms considered that service and quality of meat were much more important than price. One service was the offering of pre-cut items which could be secured in uniform serving portions. More than half of the firms secured some items in this form.

Seasonal supplies of meat were of limited importance in the preparation of menus. Only 13 firms considered seasonal supplies in their menu planning.

For more information, a copy of "A Survey of Meat Use by Chicago Hotels and Restaurants," AERR-71, may be secured from the Department of Agricultural Economics. — *M. B. Kirtley*

College Administrators Have Different Titles, Same Duties

At the request of Dean Louis B. Howard, the University of Illinois Board of Trustees has changed the titles of four administrators in the College of Agriculture, the Experiment Station, and the Cooperative Extension Service. The changes became effective April 1.

Dean Howard, whose title was formerly "Dean of the College of Agriculture, Director of the Agricultural Experiment Station, and Director of the Cooperative Extension Service," now has the title of "Dean of the College of Agriculture."

Dr. M. B. Russell, formerly Associate Director of the Agricultural Experiment Station, is now Director of the Agricultural Experiment Station and Associate Dean of the College of Agriculture.

Dr. J. B. Claar, formerly Associate Director of the Cooperative Extension Service, is now Director of the Cooperative Extension Service and Associate Dean of the College of Agriculture.

The title of Dr. Karl E. Gardner has been changed from "Associate Dean of the College of Agriculture" to "Director of Resident Instruction and Associate Dean of the College of Agriculture."

The four administrators will continue to have essentially the same duties and responsibilities as before.

FARM BUSINESS TRENDS

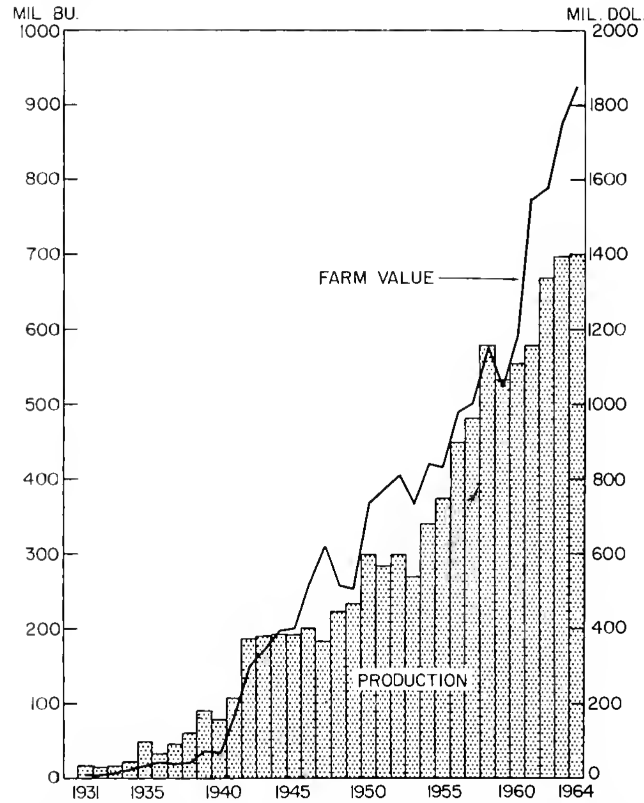
Soybeans must be the wonder crop of modern American agriculture. The farm value of the 1964 crop was 1,850 million dollars. Cash receipts from marketings of soybeans are on a par with receipts from corn and are substantially greater than receipts from wheat or tobacco. Cotton is the only crop that brings in larger cash receipts than soybeans.

Soybeans were brought from the Orient to the United States perhaps a century ago. They were first used mostly as an emergency crop for hay, pasture, and silage in the southern states. A few beans were crushed for oil, mostly in the South, in the 1920's.

Soybeans became an important cash crop in 1935, when U.S. production neared 50 million bushels. Our last two crops have been 700 million bushels, 14 times the production 30 years ago.

Illinois was the leader in soybean production when the U.S. Department of Agriculture first began to keep records on the crop. For a time in the middle 1930's, Illinois produced more than half the nation's soybeans. In more recent years production has flourished in other states, but Illinois still ranks first by a wide margin. In 1964 Illinois farmers produced 145 million bushels of soybeans, 21 percent of the national total.

The University of Illinois played a leading role in the development of the soybean crop in the United States. Research workers developed improved varieties, tillage methods, and harvesting machinery. Extension specialists encouraged farmers to grow the crop, using improved varieties and practices, and helped to develop markets for soybeans and soybean products. — *L. H. Simerl*



Production and farm value of soybeans in the United States, 1931-1964.

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Summer, 1965

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Every year thousands of Illinois farmers attend Agronomy Field Days throughout the state. This group met at the Elwood Research Center last year (page 5).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell . . . . . . Director

Adrian Janes . . . . . . Station Editor

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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NEWS AND VIEWS

The need for agricultural scientists who can "fit the pieces together"

RESEARCH is riding a strong wave of popular support in this country. Increasingly it is looked to as the stimulus for continued economic growth and as the means of reducing human suffering arising from disease, hunger, and social conflict. It was in agriculture that the benefits of research to society were first acknowledged as great enough to justify the support of research by public funds. This principle was firmly established in 1887 with passage of the Hatch Act, providing federal support for agricultural research. Now this same principle is the rationale for the tremendous increase in federal support for research in health, national defense, space, and natural resources.

Much of the federally supported research is in the basic physical, biological, and socio-economic phenomena underlying the problems associated with medicine, agriculture, engineering, and the other applied sciences. This emphasis is justified because it generates new knowledge necessary for future advances in the applied fields such as agriculture.

At the same time, the rapidly expanding support for basic research programs is creating a problem for agricultural research: It is becoming increasingly difficult to attract the high-caliber scientific personnel and support needed for the problem-oriented research that represents the traditional concern of agricultural scientists. Such research often requires that one fit together bits of basic knowledge from several scientific disciplines such as genetics, biochemistry, economics, sociology, and mathematics. Its focus is a biological system such as a cow, a field of corn, or a farm enterprise, rather than a single molecule or cell. Sustained creative and productive research on such systems is necessary if agriculture is to continue meeting the needs of people in both this and other countries. Sources of funds over and above those now available must be found and committed to this type of synthesizing research if we are to attract the caliber of scientist that is needed. — *M. B. Russell*

Economical short-time grain storage

FRANK W. ANDREW

Two sheets of plastic and a ¼- to 1½-horsepower fan may solve the problems of temporary grain storage on many farms.

The need for satisfactory, economical short-time storage often arises when a cash-grain farmer finds that he can't haul his grain fast enough to keep up with his harvesting equipment. Or he may haul the grain to his local elevator only to find himself in the frustrating position of having to compete with all his neighbors for unloading and shipping capacity. Sometimes it is desirable to store the grain temporarily before feeding or drying it on the farm.

Equipment is easily available

Large polyethylene sheets of 4 mil thickness can now be purchased for about 1 cent per square foot. The tendency of plastic to draw together under suction makes it easy to use for temporary grain storage.

A low static suction of ½ inch equals nearly 3 tons of force on a 20- by 100-foot area. Motor-driven fans are available that will develop at least this much suction at either full capacity or zero air delivery, and will operate continuously without harm.

Plastic and fan tested

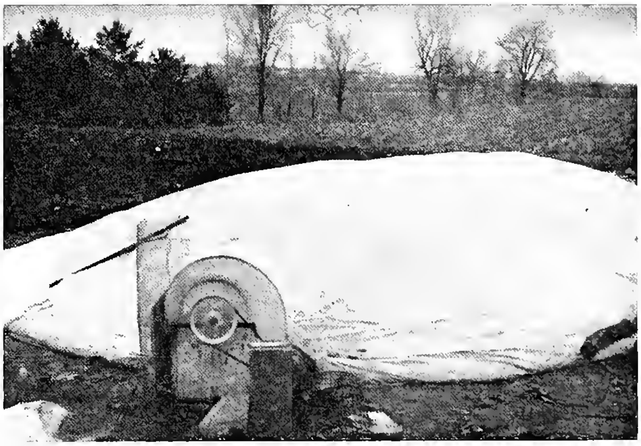
Last year, in a test at Urbana, 700 bushels of clean shelled corn, moisture content 19 percent, were stored between two sheets of 20- by 50-foot 4 mil plastic.

The bottom sheet was laid on an area which was near electric power and which had been slightly smoothed and leveled. Two combines, one on either side of the sheet, unloaded the corn directly onto the plastic. The unloading augers were high enough to make the pile of grain as tall as necessary for it to reach its own level of repose and stay about 6 inches from the edges of the sheet.

The top layer of plastic was pulled over the pile of grain. The lower edges of the bottom sheet were turned up 4 or 5 inches and the edges of the top sheet were tucked underneath. This operation was surprisingly simple. Grain on the edge of the bottom sheet rolled out slightly to complete the seal. When ¼ inch of suction was applied to the grain pile, the top sheet was immediately pulled tightly into place against the grain.

Suction was applied with a forced warm air furnace fan having a single inlet and a ¼-horsepower motor. The suction side of the fan was tied to the two sheets and the intake was extended about 2 feet into the grain mass by means of a screened inlet. The fan ran continuously. To cool the grain, a small flap about 6 inches square was opened each night at the end of the pile opposite the fan. The flap was closed during the day to prevent warming and development of a drying front.

Shelled corn was unloaded directly from the combines onto polyethylene sheeting because the field was near electric power for operating the suction fan. (Fig. 1)



A ¼-horsepower motor and fan ran continuously. This provided suction to hold the plastic against the grain and also pulled in night air for cooling when a small flap was opened at the opposite end of the pile. (Fig. 2)

The grain was marketed after 40 days. A portable auger was used to load the grain into the truck. A large pile of grain could probably be handled with a front-end loader.

Storage pays for itself

During the 40-day storage period, the value of the grain increased 10 cents a bushel, which is a fairly usual trend. This price increase was enough to cover the cost of materials (3½ cents a bushel), electricity, and reloading of the grain. If carefully handled, half of the plastic may be reusable, further reducing the cost.

Frank W. Andrew is Associate Professor of Agricultural Engineering.

Some recommended storage conditions

Either black or translucent, 4 or 6 mil plastic may be used for temporary grain storage. Two 20- by 100-foot sheets will provide storage for about 1,500 bushels if the grain is piled high enough to make the angle of repose about 30° with the horizontal.

Two 40- by 100-foot sheets will accommodate 10,000 to 12,000 bushels at a cost of about 1 cent a bushel. Grain should be piled only about 12 feet high and 34 feet wide on the bottom sheet so that a 40-foot top sheet can reach across the top and be tucked under at the edges.

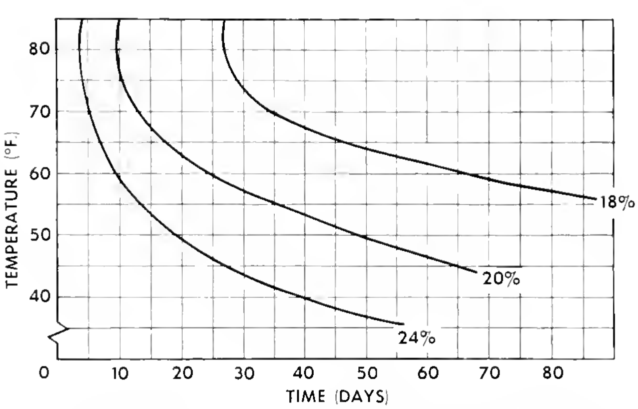
Present aeration fans can be easily adapted to develop the necessary suction and to draw cooling air through the grain at night. A ¼-horsepower fan and motor developing ½ inch of suction is adequate for 700 to 1,500 bushels. If 10,000 to 12,000 bushels are stored between 40- by 100-foot sheets, a 1½-horsepower fan and motor developing 3 inches of suction and 1,000 c.f.m. of air should provide aeration and hold the material in place.

A continuous power supply is important but short failures will not be serious because the grain helps to hold the plastic in place. When the aeration flap is closed the only way for air to get into the grain, even on windy days, is through the exhaust opening of the fan.

The length of storage depends on the moisture-temperature-time relationship shown in Figure 3. Ground temperature at the time of storage is an important consideration. The bottom part of the grain in the center of the pile will stay at or near this temperature for some time.

When the ground temperature is 60° F. and grain moisture is 19 percent, it is fair to estimate that the bottom half inch or so of grain can be stored about 30 days. Perhaps a layer of dry grain should be put down first to help solve this critical ground temperature problem.

Sunlight penetrating the translucent plastic during the test produced a surprising effect. Apparently the



How temperature and moisture content affect storage time for corn. Temperature, moisture, and time are important relationships when using temporary storage. If grain is cooled by aeration at night, storage time can be extended. (Fig. 3)

warming of the grain caused moisture to accumulate inside the plastic. However, the tightness of the plastic against the grain caused the moisture to be reabsorbed in the surface layers without causing damage.

Weather and other problems

Usually one of the worst problems in using plastic is to keep it in place during strong winds. It is obvious, however, that the bottom sheet cannot blow away with several hundred bushels of grain holding it down, and this same grain also presents an immovable base against which the top sheet can be held by suction. A static suction of ¼ inch develops 1½ pound of pressure per square foot, which is distributed uniformly over the thin film. When there are no ripples, openings, or loose spots, there is no way for the wind to get under the plastic, and the entire unit remains stable. The fact that the storage is only a few feet high also reduces the effect of the wind.

If part of the plastic is open or comes loose and the air comes in faster than the fan can draw it off, then the suction pressure will be reduced to nearly zero, making it difficult to keep the plastic in place.

Snow and rain cause no difficulty. Even though a large amount of water may build up against the plastic, it will not penetrate the seal formed when the edges of the lower plastic sheet are turned up and the edges of the upper layer are tucked underneath. We have had no experience with hail, but hailstones might penetrate the 4 mil plastic.

Rats and mice do not appear to be a problem with this type of storage, apparently because it is temporary and also because it is clean with no hiding places, and the only way that animals can get underneath is by burrowing. Furthermore, there is no odor of grain except at the exhaust fan.

The greatest problem was caused by dogs running over the plastic and breaking it with their claws or by small children climbing on the pile of grain and breaking through it. Fortunately these holes were easy to repair. The grain was pressed against the plastic around the opening to hold off most of the water that might go through it, and the hole was covered with a small piece of plastic. This was weighted down with a board or brick, to be held in place by suction. Obviously if there are livestock around, additional precautions must be taken to prevent them from trampling or rooting the structure.

Good management essential

Although suction-controlled plastic has proved satisfactory, as well as economical, for temporary grain storage, careful management must be exercised to use this system successfully.

The most important management practice is to use cool night air for cooling the grain, but to keep out warm air in the daytime. An automatic control for operating the aeration flap is being developed.

Agronomy Field Days and on-farm demonstrations attract many visitors in all parts of the state

W. D. Pardee, Extension Agronomist, discusses alfalfa varieties with Field Day visitors at Urbana.

W. D. PARDEE

WHAT'S NEW in fertilizers? In weed control? In crop varieties? By the end of this summer, thousands of Illinois farmers will have spent a half day or evening learning the answers to these and other questions about crop production. Over 5,000 will have attended Field Days at agronomy research centers and experiment fields throughout the state. Many more will have met at county demonstration plots.

Extension workers and research agronomists join in putting on more than 100 of these popular events each year. The main feature is the chance to "see for yourself" and to discuss research results with those who are doing the work.

Field days

Biggest attractions are the 19 Field Days. These are held at 6 major research centers, ranging from the Northern Illinois Center in DeKalb county to Dixon Springs in the south; and at 11 additional experiment fields.

Research underway at these centers and fields varies according to the area of the state and the local farmers' special interests. In southern and central Illinois emphasis is on wheat, soybeans, corn, and forages, with ways being sought to improve crop yields and farm incomes. Oat trials and intensive alfalfa production are added to the programs in northern Illinois.

Featured trials in recent years have shown the yield increases possible from narrow-row soybeans and corn. Other studies in both northern and southern Illinois have pointed up advantages for early-planted corn. Every field has a wide range of fertility plots, demonstrating the value of a good over-all fertility program.

Agronomy experiment fields and research centers are rooted in the desire of Illinois farmers for up-to-date production information. Each was originally set up and financed through local subscriptions. Farmers and businessmen contributed the necessary funds and helped to get each field started. Operating funds come from state and federal sources, but local people remain intimately involved.

University of Illinois area agronomists are the key men in both research and extension activities on these centers and fields. Derreld Mulvaney heads the work in northern Illinois; Gene Oldham takes charge in western Illinois. Pat Johnson continues his long-term leadership in south-central Illinois, while Les Boone covers southern and southwestern areas of the state.

On-farm demonstrations

County extension workers, farmers, and agronomy specialists also join in establishing on-farm demonstrations throughout the state. These include 40 to 50 demonstrations each of wheat, oat, and alfalfa varieties, over 70 soybean variety comparisons, and demonstrations of herbicide use and of fertility.

"Stop and compare" is the theme of these demonstrations, usually located on main highways for easy access. Many farmers attend twilight meetings, day meetings, even before-breakfast meetings at these plots, to compare the new with the old.

Opportunity for learning

At both Field Days and the meetings at county demonstration plots, farmers are free to ask questions — and they certainly do. Hard-to-answer questions often point the way to new research.

Farmers also get a chance to compare notes with other farmers from nearby areas. Field Days are social affairs, as well as times for learning. Several include lunches; at others the tour may end with a watermelon spread.

Yet the heart of an Agronomy Field Day or demonstration is the research. Many have learned new things at a Field Day that brought them increased income. As one Illinois farmer commented last year, "I once thought I couldn't afford the time to come to this Field Day; now I know that I can't afford to stay home."

If you have not yet attended a Field Day or demonstration, there's still a chance to do so this year. Your farm adviser can tell you the time and place of the next event in your area.

ESTABLISHING TURF on Illinois roadsides

O. N. ANDREWS, JR. and J. A. JAKOBS

Species are being evaluated and other approaches made to the many problems of establishing and maintaining cover on our highway right-of-ways

All citizens have a stake in the establishment and conservation of good cover on our roadsides. As travelers, they welcome a pleasant vista. As taxpayers, they want to see maintenance costs reduced and tax dollars effectively utilized. Those who own property near the highway right-of-way have a special concern for its tidy appearance.

Across the United States half a million acres are under construction in highway right-of-ways. Safe adequate highways are understandably expensive. About 2.5 percent of the construction cost goes to establish turf on the roadside. After highway construction has been completed and an initial effort made to stabilize the roadside, one of the primary costs is that of roadside repair.

Complex problems

In Illinois, where there are 21 million acres of the best tillable land in the world, turf establishment along the roadsides presents many complex, constantly changing problems.

Most roadside seedings must be made in subsoils, very often on cut slopes. Of the undesirable characteristics found in subsoils, these cause the most difficulties: poor moisture relationships, low soil nitrogen, acid or alkaline conditions, low available phosphorus, and minor-element toxicities and deficiencies.

The ideal turf species for roadside seeding would establish itself rapidly on subsoils; withstand drouth, flooding, and freezing; never grow very tall; present no fire hazard; and remain green most of the year. Lacking such an ideal species, we have to search for those that come closest to filling the requirements.

The difficulties of roadside turf establishment are further complicated by the problems of construction contracts. Most highway right-of-way seedings are made under subcontracts. For the highway contractor to bid sensibly on the total contract, he has to know the fertilizer that will be used, seeds and seeding rate, mulch, method of seedbed preparation, and method of seeding. It is often difficult to obtain satisfactory turf establishment when planning has to be done before construction is started.

The Illinois Division of Highways has long recognized these problems and taken positive action toward their solution. One step has been to support grass-establishment research that has been underway for several years in the Agronomy Department of the Illinois Agricultural Experiment Station. The U.S. Bureau of Public Roads has also cooperated in this research.

What is being done

Several areas of research are included in the present turf-establishment project. Extensive work has been done to develop techniques for doing the research; a comprehensive review of literature has been compiled; and present procedures for turf establishment have been evaluated to determine their relationships to agricultural practices. These efforts have been necessary to provide a firm basis for roadside research.

Over 150 grass and legume species at several sites have been screened for roadside use. One of the most promising has been alfalfa, which is not normally considered a turf species. It has established itself quickly and provided excellent ground cover.

Of the grass species, tall fescue has proven most adaptable for highway right-of-ways. Kentucky bluegrass, normally an ideal turf species, has not performed well in highway seedings because of its lack of seedling vigor. It does, however, invade roadside vegetation, consequently providing an excellent turf. Despite its lack of seedling vigor, bluegrass is considered the most desirable grass species for roadside seedings in the northern third of Illinois.

Korean lespedeza provides good ground cover in most areas of the state. Because it is an annual and must re-establish, however, it varies widely from year to year in its contribution to the vegetative cover.

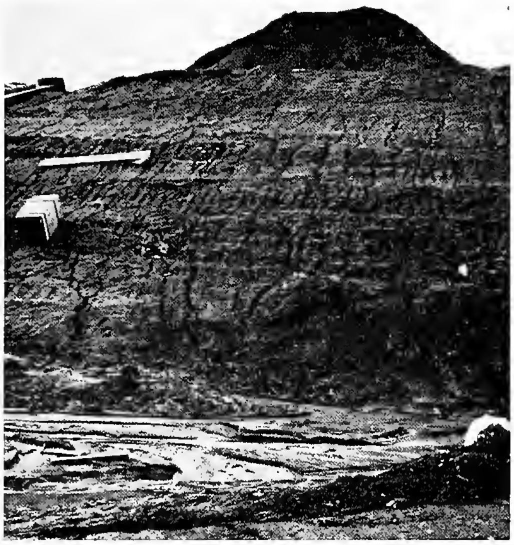
Soil samples from raw-cut highway slopes have been analyzed to determine their pH, available phosphorus, and available potassium. Many of the subsoils had a very high pH, indicating that lime was not needed. Samples were often extremely low in available and total phosphorus. Available potassium was deficient in some soils but was sufficient in others.

Experimental seedings responded well to applications of nitrogen. In roadside seedings 60 pounds of nitrogen per acre are considered sufficient. Split applications are desirable.

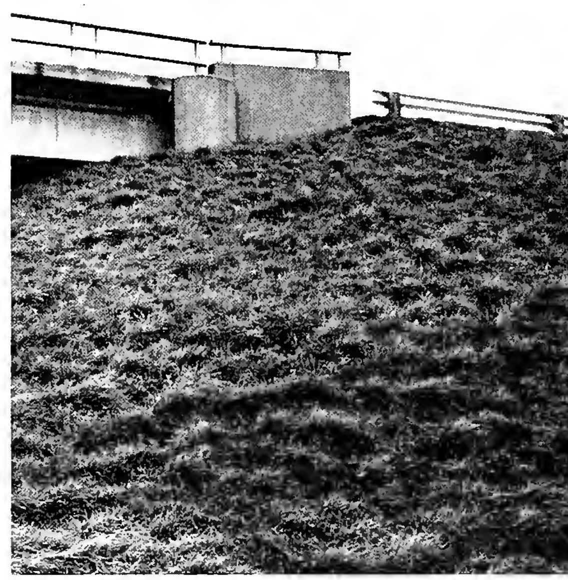
Because roadside seedings must be made after road construction is finished, it may be necessary to seed at any time during the growing season (May to November). In an experiment near Effingham, permanent seedings were successfully made throughout this season. Of the temporary species, oats were superior to

O. N. Andrews, Jr., is Assistant and J. A. Jackobs is Professor, both in Crop Production. This article reports work done by the Agricultural Experiment Station in cooperation with the Illinois Cooperative Highway Research Program. The authors acknowledge the assistance of the Project Advisory Committee: John E. Burke, C. R. Wright, Theodore H. Ebel, Harleigh R. Kemmerer, and B. J. Butler.

The challenge . . .



. . . and the goal



cereal rye in terms of the subsequent permanent cover. All temporary seedings, however, delayed the establishment of permanent species. The ground cover was improved by adding alfalfa to the seeding mixture.

An effort is being made to develop a mathematical model from which one can predict the rate at which an individual species will become established. If the model is developed, it can be used in determining whether to reseed, renovate, or leave a new seeding undisturbed.

The results of these experiments are being incorporated into the work of the Illinois Division of Highways. The results will be better erosion control and a better appearance for Illinois roadsides. Although the difficult problems of roadside turf establishment are not completely solved, they can be minimized through the cooperation of the biologist and engineer working toward the common objective of beautification and erosion control.

Measurements for predicting the value of LIVE HOGS AND PORK CARCASSES

B. C. BREIDENSTEIN, VIRGIL M. ROSENDALE, and DONALD S. GARRIGAN

Much effort has been put forth in recent years to develop economical, rapid, and accurate methods of determining value differences in meat animals. Such information is useful not only in identifying superior breeding animals, but also in selecting good meat animals at the market.

The traditional measures of meatiness in the pork carcass have included backfat thickness, carcass length, and loin eye area. These measures, alone or in combination, have been correlated with some quantitative measure of lean content — usually the amount of four trimmed lean cuts (ham, loin, boston butt, and picnic), expressed either as pounds or as a percentage of the chilled carcass. As the result of many studies it is now possible to predict the percentage of four lean cuts pretty accurately from simple measurements.

What has been largely disregarded so far has been the distribution of the meat among the four lean cuts and the price differences between these cuts. A question therefore arises as to whether the traditional measurements of meatiness can determine dollar value accurately.

A recent study at the University of Illinois attacks this question. The previously reported measures and their relation to leanness were studied. In addition, we examined the reliability of these measures when the distribution of lean, as indicated by the dollar value of the animals, was taken into account.

The primary questions to which we sought answers were: How accurately can one predict value by the use of simple measurements? How accurately can one predict value through the use of limited cut-out information?

B. C. Breidenstein is Associate Professor of Meats Technology; Virgil M. Rosendale was formerly an Assistant and Donald S. Garrigan is at present an Assistant, all in the Department of Animal Science.

Procedures

Included in the study were 443 barrows and 81 gilts, representing six breeding groups, which had originated at the University of Illinois Swine Farm. The animals were full-fed a finishing ration until 12 hours before slaughter, when they were taken off feed. Live weights just before slaughter ranged from 180 to 240 pounds.

All animals were dressed packer style. Carcass length, carcass backfat thickness, and loin eye area at the tenth rib were measured and recorded in the conventional manner.

Both sides of the carcass were cut to minimize error in determining the weight of the cuts. All portions except feet, tail, and neck bones were weighed after careful trimming according to standard procedures.

Percentages of skinned ham, loin, regular picnic, and boston butt were determined on a chilled weight basis. The sum of these percentages was the percentage of four lean cuts.

The weight of each cut in a carcass was multiplied by the price per pound for the appropriate weight range. Values of the cuts were then added to determine total dollar value of the carcass.

Characteristics of Animals in Study

Characteristic	Mean	Standard deviation
Age in days	177.7	21.50
Live weight, lb.	200.2	11.24
Carcass weight, lb.	144.1	9.04
Average carcass backfat, in.	1.56	.23
Carcass length, in.	29.16	.99
Loin eye area, sq. in.	3.49	.50
Carcass pct. ham + loin	31.90	1.97
Carcass pct. four lean cuts	47.40	2.61
Dollar value/cwt. of carcass	$ 25.51	$ .74
Dollar value/cwt. alive	$ 18.36	$ .67

In figuring the price per pound for the various weight ranges of each cut, we used the average weekly carload bid prices for 1961, 1962, and 1963, as given in the National Provisioner. Prices were figured by this method because hogs are bought primarily on a weight basis and because there is a price differential for various weight classes of wholesale cuts. This pricing system was therefore presumed to reflect live and carcass values on the basis of current market prices.

Multiple linear regression equations were used to determine the accuracy of value predictions based on carcass backfat, carcass length, and loin eye area. The accuracy with which these measures predict values is reflected in the standard errors of the equations. One would expect the predicted value to be within one standard error either above or below the value in 65 percent of the cases.

Mathematical adjustments were made to eliminate differences due to breed, sex, season, live weight, and carcass weight. Carcass information can be used to predict values only within a group of comparable animals; that is, they must be of the same breed and sex and must be similar in age and live weight.

Accuracy of predictions

By use of average carcass backfat, carcass length, and loin eye area, carcass value could be predicted with a standard error of \$.437 per hundredweight, and live value with a standard error of \$.316 per hundredweight. Each increase of 0.1 inch in backfat resulted in a decrease of

Cut-out data in this study reflected a close trim on the four lean cuts, as shown above. From left to right the cuts are ham, loin (in two pieces to show where the loin eye is measured), picnic, and boston butt.

$.121 a hundredweight in carcass value and of $.085 a hundredweight in live value. Each 1-inch increase in carcass length increased the value of the carcass by $.226 per hundredweight, and the value of the live animal by $.158 per hundredweight. An increase of 1 square inch in loin eye area resulted in an increase of $.656 per hundredweight of carcass and $.475 per 100 pounds of live weight.

Since some question has been raised about the use of carcass length in meat hog evaluation, a multiple regression equation was calculated that excluded carcass length. Eliminating the carcass length increased the standard error, but only slightly. Carcass value was predicted with a standard error of $.467 per hundredweight, and live value with a standard error of $.355.

Use of the percentage of ham and loin in the carcass lowered the standard error to $.282 per hundredweight in predicting carcass value and $.205 per hundredweight in predicting live value. Each increase of 1 percent in the ham and loin resulted in an increased value of $.318 per hundredweight for the carcass and $.227 per hundredweight for the live animal.

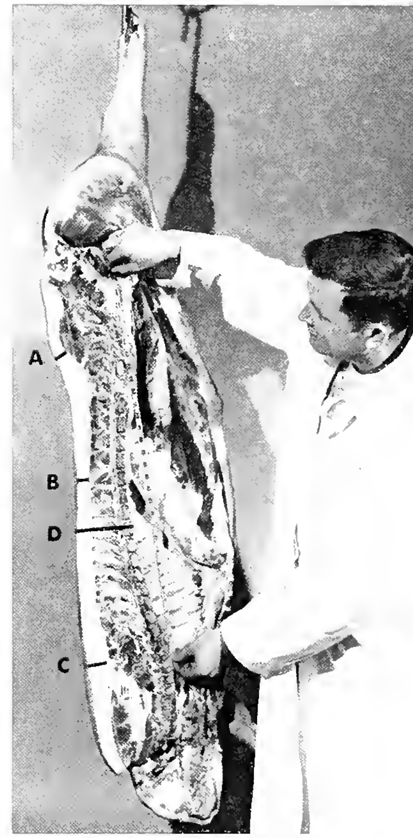
The standard error was further reduced when the percentage of four lean cuts was used to predict value. This measure predicted carcass value with a standard error of $.278 per hundredweight; live value with a standard error of $.203 per hundredweight. Each increase of 1 percent in the four lean cuts resulted in an increase of $.244 per hundredweight of carcass and $.174 per 100 pounds of live weight.

To compare the standard errors of the different measures or combinations of measures, it is helpful to express the error as a percentage of the mean for the values being predicted. Figured this way, the standard error in the prediction of carcass value was 1.71 percent for the combination of backfat, length, and loin eye area; 1.83 percent for backfat and loin eye area only; 1.11 percent for the percentage of ham and loin; 1.09 percent for the percentage of four lean cuts.

On the same basis, the standard error in predicting live value was 1.72 percent for the combination of backfat, length, and loin eye area; 1.82 percent for backfat and loin eye area alone; 1.12 percent for the percentage of ham and loin; and 1.11 percent for the percentage of four lean cuts.

Conclusions

It seems justifiable to conclude that backfat, length, and loin eye area measurements can be used to predict the value of live hogs or pork carcasses with reasonable accuracy. Elimination of carcass length from the equation did not appreciably reduce accuracy. The use of cut-out information — either percent of ham and loin or percent of four lean cuts — appreciably increased the accuracy of the predictions.

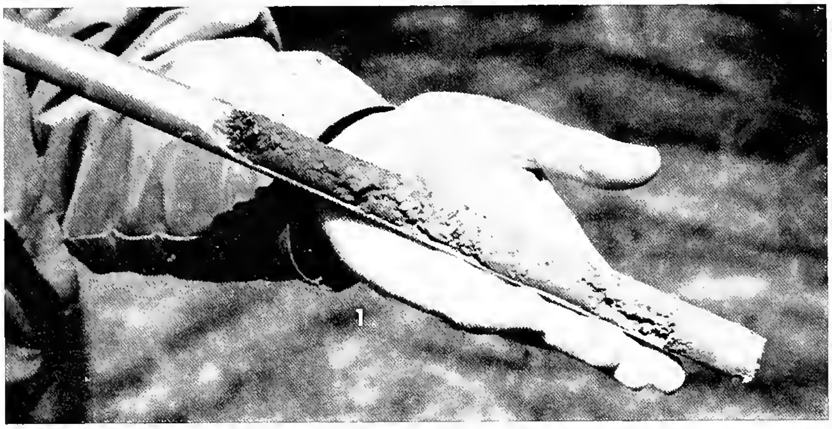


Length of carcass is measured from the front of the first rib to the front of the aitch bone. Backfat thickness is the average of measurements at A, B, and C. Loin eye area is the cross section of the large loin (pork chop) muscle, between the tenth and eleventh ribs (D).

Although cut-out information gave accurate predictions, it should be remembered that all data were collected under highly standardized conditions. Such standardization may well exist within a given packing plant, but it is not likely to exist between plants. Hence, comparisons of values within a plant could well utilize cut-out information, but such comparisons between plants may be risky. Since measurements such as backfat, length, and loin eye area are more easily standardized, it is probable that value comparisons between plants would be more meaningful when based on these three measures.

INSTRUMENTS THAT MEASURE SOIL MO

A. R. GILMORE and H. A. CATE



If you visit the Dixon Springs Agricultural Center in southern Illinois, you can see several instruments for measuring soil moisture, side by side in a pine plantation.

Accurate measurements of moisture are necessary for study of plant-soil moisture relationships. Although the ultimate in instrumentation has not been achieved, the scientist can choose from several types of instruments. Some are more precise than others; some, more flexible; some, more easily used and maintained.

The side-by-side installation, set up by the Forestry Department, exhibits the advantages and limitations of each instrument and permits a quick review of instrument development. The pictures on these pages give an idea of what you would see, even if you can't get to Dixon Springs in person.

The soil sampling tube is the field tool for the gravimetric method of soil moisture determinations (picture 1). Samples are weighed, oven-dried for 24 hours, and weighed again, and moisture is calculated as a percent of the dry soil. The gravimetric method is the oldest and most reliable, against which other methods are checked and calibrated. It cannot, however, measure continuous moisture changes in close soil-root associations. Other limitations are the time lag and soil disturbance involved.

The tensiometer, which measures capillary pull, was one of the earlier methods for determining soil moisture in place. The small, porous pot filled with water disturbs soil and plants very little as it is inserted into the soil (picture 2).

A tube connects the porous pot to a glass-contained column of mercury (picture 3). As the soil dries, soil moisture tension increases, pulling the column of mercury up in the glass tube. The tensiometer is useful for measuring decreases in soil moisture but not increases. It is not precise, especially at the lower moisture range.

The dial tensiometer (picture 4) is less cumbersome than the older mercury instrument. Because the dial tensiometer is flexible and easy to use, it has value in determining when field irrigation is needed. Except for its greater flexibility, it has about the same limitations as the mercury instrument.

A. R. Gilmore is Assistant Professor of Forestry and H. A. Cate is Associate Professor of Agricultural Extension, Dixon Springs Agricultural Center.

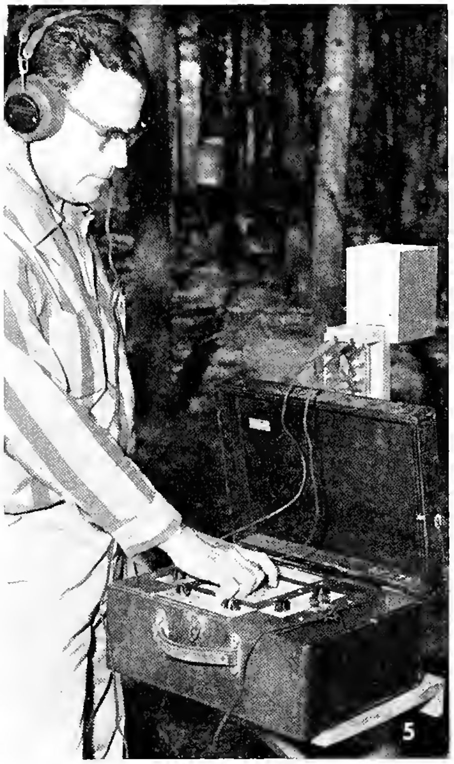
STURE

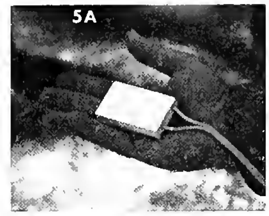
ectrical **resistance** indicates soil
oisture tension throughout the range
usable moisture. The instrument
picture 5 measures electrical re-
tance between two electrodes im-
dded in a buried gypsum block
A). As soil moisture drops, elec-
cal resistance increases. The de-
ee of resistance is indicated by a
ll in the high-pitched sound trans-
ssion which is received by the man
erating the galvanometer. Limita-
ns of this method are that the soil
disturbed in placing the gypsum
ock and electrical resistance is af-
ted by temperature and salts.

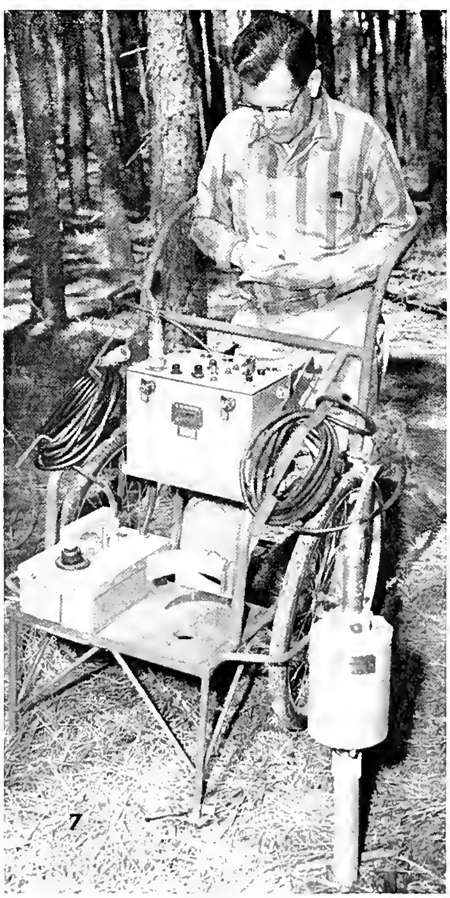
finements of the electrical resis-
nce method have increased its ac-
racy and convenience. Direct dial
ding frees the operator from the
adset (picture 6). The gypsum
ock is replaced by a fiberglass wafer
a metallic case (6A). The wafer
ntains a thermocouple as well as
conventional electrodes. It is
ore durable than the gypsum block
d is less affected by temperature
d salts. It can be placed in the
ound with very little disturbance to
soil.

e **neutron probe** is the most re-
nt addition to soil-moisture mea-
ing devices. To measure subsur-
e moisture, a radioactive source
d detector in the depth probe are
vered into a tube or pipe (pic-
e 7). Neutrons emitted from the
dioactive source are slowed by hy-
ogen atoms, which occur mostly in
ter. Thus the amount of water in
soil is correlated with number of
w neutrons picked up by the de-
tor and recorded by the counter.

adioactive source and detector are
o used to measure surface soil
isture (picture 8). The neutron
be is relatively flexible and por-
le, measures moisture in undis-
bed soil-root association, and is
sitive to moisture changes occur-
g during a short period of time.
ce neutrons are scattered over a
ume, the neutron probe also gives
more practical soil-moisture pic-
e than other devices.







AGRICULTURAL DEVELOPMENT IN TURKEY: a case study of a village economy

L. P. FETTIG

It's a long way from Illinois to Ulucak, Turkey, not only in miles, but also in economic development. Through modern transportation and communications, the gap in miles can be bridged. Through economic and advisory programs soundly based on research, the gap in economic development may be diminished.

Economic development can be defined as rising per capita incomes with a consequent rise in standard of living. Agricultural development is vitally important in a country's economic development, both for the production of food and fiber, and for the release of workers to other industries.

The United States is now trying to speed the economic development of many countries through programs such as the Alliance for Progress and use of surplus commodities under Public Law 480. The successes and failures of our programs have demonstrated that much research is needed to make our aid more effective. We can't, as a rule, just transfer American "know-how" to less developed countries without any adaptation.

A number of good reasons, some of them interrelated, can be advanced to support U.S. research on the economic development of other countries. Humanitarianism and mutual defense might head the list. We also need to find the best use of economic assistance dollars, to expand both import and export markets, and to increase the understanding of teachers and students, both at home and abroad. These reasons are all underlined by the transportation and communication changes which are shrinking the size of our world.

The Agricultural Development Council, among other activities, makes grants to American university professors "to facilitate research in international economic development." Such a grant made it possible to study the economy of Ulucak.

Some facts about Turkey

About five times the size of Illinois, Turkey is located on the same range of latitudes, at the gateway between Europe and Asia.

Constantinople (now Istanbul) was the capital of the Ottoman Empire, which lasted from about 1300 until the close of World War I. When the empire collapsed, the present Republic of Turkey was formed under the leadership of Mustapha Kemal (Ataturk). Among other changes, he replaced Arabic with the new Turkish language in 1923 and separated the government from the Moslem religion. Nearly all the people are still Moslem, however, and many still hold to traditional ways despite the cultural changes taking place in and near the larger cities.

Turkey's trade balance was negative in all years between 1950 and 1964, with import value exceeding export value by one-third ($31 million) in 1964. Its overall international trade balance has been maintained through liberal economic assistance, primarily from the United States. Between 1949 and 1962, Turkey received $1,615.9 million of U.S. economic assistance. Grants accounted for $831.8 million of this total, and $377.5 million was via PL 480 surplus commodities.

Industrial production increased from a base of 100 in 1948 to 255 in 1961. During the same period wholesale prices rose from 100 to 270. The government participates very heavily in the economy, and in 1960 employed about 40 percent of all workers in manufacturing.

Because of limited rainfall, most farming in Turkey is done under dryland conditions, although many of the coastal river plains are irrigated. Land reform is of much concern. At one extreme, very large tracts of land are often owned by absentee landlords and at the other extreme, many farmers operate very small scattered parcels.

The livestock industry is at a rudimentary stage. Pastureland, which is owned by the communities, is badly overgrazed as no fee is charged for its use. This intensifies the erosion problem, already serious in much of the country because of the hills.

The average diet in Turkey is high in cereals and other starchy foods. Only about 20 percent of the protein comes from animal sources.

Farmers generally live in villages rather than on the open land. For administrative purposes, each village is related to a larger town, which in turn is related to a city, and thus to the central government.

L. P. Fettig is Assistant Professor of Agricultural Economics.

The village of Ulucak

Ulucak is about 15 miles north of the city of Izmir, which is near the western coast. The population of Ulucak is 1,780 (364 families).

Most of the villagers work on their own farms or for other farmers. Cotton is the main crop, since most of the cropland is on an irrigated river plain. The other principal product is milk from cows, sheep, and water buffalo.

A few villagers work at a local tile factory or as groundsmen at a nearby NATO air base (for which the government expropriated land from the villagers).

In several respects the villagers have higher standards of living than many peasants in Turkey. Houses are made of sun-dried brick, stones, and mortar, and generally have tile roofs. A diesel engine furnishes electricity for street lights and for the nine coffee houses and the mosque. The village plans to connect with a government power line in the near future, thereby making electricity available for home use. Water is supplied by community lines from the mountains. There are no sewers.

The village is near the railroad line between Izmir and Menemen and is also on a hard-surfaced road. Most transportation of goods, however, is by horse and cart, pack donkey, or tractor, as none of the villagers owns an automobile.

Goals of study

The specific goals of this project are to determine the present production, marketing, and income in Ulucak; availability and terms of loans; and potential adjustments in production and income, given the resources and loan possibilities.

Data were collected during a 6-week period in Turkey. Supervised Turkish graduate students from Aegean University interviewed a random sample of all farm operators in the village. Professor Hasan Eroglu and I interviewed the lenders.

The data collected are now being tabulated for analysis by regression and linear programming techniques, to determine potential adjustments. Some of the data are summarized below.

Agriculture of Ulucak

Of the 50 interviews with farm operators, 43 are completely usable, and form the basis for the information given here.

Farm size distribution among the 43 operators was representative of that in the entire village, as estimated by the village leader and his council. About 70 percent of the farms are very small, averaging 7 acres (28 decares); 20 percent average 27 acres; and the other 10 percent, 61.5 acres. Some data for the farms and operators in these three size groups are given in the table.

Average age of the operators was very similar in all three groups, and educational levels were generally low. All children are now required to attend school for 5 years, so some improvement is being made in education.

Men, women, and children all work on the farms, particularly in the peak seasons of planting, hoeing, and harvesting cotton. In addition, extra labor is hired in the busy seasons, usually at the rate of about a dollar a day. Young men and boys are also hired to tend sheep and cattle since grazing areas are not fenced. Farmers who do not have wheel tractors commonly custom-hire field preparation and cultivation.

Not only are the farms small, but they usually consist of two or more parcels which are seldom adjacent to one another. The average number of fields per farm, given in the table, indicates the smallness of the parcels.

Fertilizer use on the cotton land is high, partly because the villagers observed the results obtained by one farmer who adopted the practice about 5 years ago, and partly because credit is available in the form of fertilizer. Before the widespread use of fertilizers, yields had been declining substantially. In 1964, however, average acre yields (unlinted basis) ranged from 1,936 to 2,068 pounds. A disease-resistant American variety is the only one grown.

Loans

Loans are available to the village farmers from four primary sources — merchants who buy cotton or milk, and the governmental Agricultural Bank, Credit Cooperative, and Sales Cooperative. Merchants charge interest of 25 to 80 percent (annual basis) for loans which extend over the production period. Interest rates paid to the government sources range from 3 to 12 percent, depending on the purpose of the loan, and a farmer must have 100 percent collateral. No loans are made for land purchase, and most loans are short-term. Under existing resource and loan conditions, it seems nearly impossible to break out of subsistence agriculture.

A pilot experiment is now being conducted in Denezli, Turkey, on adapting supervised credit to Turkish conditions. It is unfortunate that not enough is known to apply such a program more generally, but recognition of this lack of knowledge improves the chance of future success. Much research is needed for economic development, and the solutions are not usually easy.

Selected Characteristics of Ulucak Agriculture, by Three Size Groups of Farms, 1964 Sample

Size group, decares[a]	Total no. of farms	Aver. operator		Aver. decares		Aver. no. of fields	Aver. fertilizer, lb. A.	Aver. cotton production, lb. A.[b]	Aver. no. of wheel tractors
		Age, yr.	Education, yr.	Farmed	Owned				
3-50	30	46.7	2.2	28	21	2.7	361	2068	0.1
51-150	9	44.9	3.4	109	56	5.1	466	1954	1.0
151-325	4	46.2	2.5	246	129	8.1	431	1936	1.5

[a] A decare equals ¼ acre. [b] Weight of cotton includes seeds.

Controlled-atmosphere storage for fresh fruits and vegetables

Storage life of refrigerated fruits and vegetables is prolonged by reducing the oxygen and increasing the carbon dioxide in the atmosphere

A. I. NELSON

How LONG fresh fruits and vegetables can be kept in cool storage depends a great deal upon what's in the air.

In normal respiration, fruit and vegetable tissue utilizes oxygen and hexose sugar or other organic materials with enzyme catalysts in a complex oxidation system. Carbon dioxide, water, and heat energy are liberated in the process.

Respiration takes place as long as the tissue is alive, continuing after harvest while the product is in storage. Aerobic respiration (or respiration involving adequate oxygen) is accompanied by the natural or physiological breakdown of the products. This breakdown occurs in different ways. Harvested sweet corn, for example, rapidly loses sugar and consequently its fresh, sweet taste. Respiration is rapid in harvested apples at room temperature, resulting in a number of objectionable changes. The skin of the apple loses its green base color and the flesh becomes soft and mealy. Taste appeal declines with the loss of acidity, sugar, and other flavor components.

Ways of reducing respiration

How can respiration be reduced or controlled in harvested fruits and vegetables? The time-honored method has been to store them at low temperatures. If temperatures are near freezing, they will reduce respiration effectively and economically, but they will not halt the process. Respiration and physiological breakdown continue, although at a reduced rate.

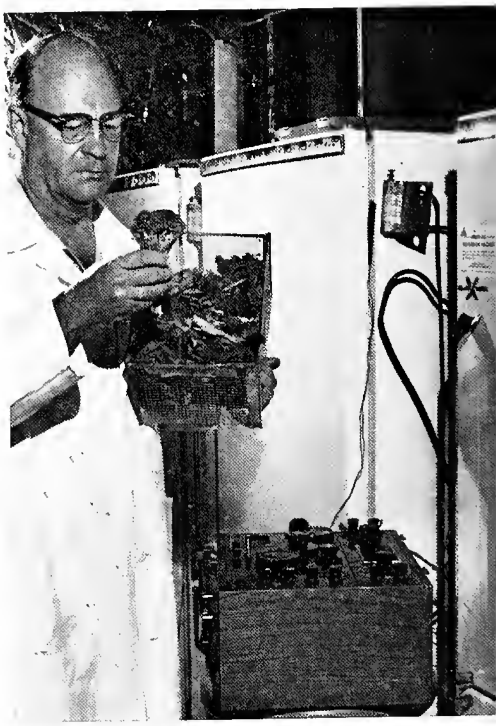
Research studies have shown that respiration rate can be further reduced by decreasing the amount of oxygen and increasing the amount of carbon dioxide around the refrigerated fruits and vegetables. If oxygen is essentially depleted, however, or if carbon dioxide is increased to exceptionally high levels, respiration is so modified that product quality is not maintained.

Anaerobic respiration (respiration occurring with inadequate oxygen) is a complex process. Its end products include reduced amounts of liberated carbon dioxide and heat energy as well as ethyl alcohol, acetic, formic, oxalic, and propionic acids, and many other compounds. The process is accompanied by physiological breakdown and spoilage. Fruits and vegetables which have undergone anaerobic respiration have a fermented or foreign flavor and odor. The particular odor and flavor will vary with different products, but will almost invariably be undesirable, and may sometimes be actually disagreeable.

Obviously, enough oxygen should be maintained around fruits and vegetables to prevent anaerobic respiration. How much oxygen is necessary varies widely among the different products. Some can maintain aerobic respiration in an atmosphere of 0.5 percent oxygen, while others require at least 4 or 5 percent oxygen.

Early use of controlled atmosphere

Storage of apples in a controlled atmosphere has found limited commercial use for many years. Research



A. I. Nelson, Professor of Food Processing, Food Science Department, examines broccoli which has been under refrigeration in a controlled atmosphere. Modified household freezer-refrigerators are used for holding products at similar temperatures in a controlled atmosphere and in air. Instrument in lower part of picture checks refrigerator temperatures.

on the subject goes back to 1935, when Kidd and West began work in England. They allowed the apples to develop their own controlled atmosphere. An airtight cool-storage room was filled to capacity with apples and was completely sealed. As the apples respired, they used up the oxygen supply and steadily in-

creased the carbon dioxide concentration.

Normal air contains about 78 percent nitrogen, 21 percent oxygen, and 0.03 percent carbon dioxide plus traces of inert gases. After several weeks of airtight storage, the respiration of apples will reduce the oxygen level to about 5 percent. This level can be maintained by controlled venting of air into the storage room.

Carbon dioxide can be kept at any desired level from 1 to 10 percent by passing a portion of the controlled atmosphere through a scrubber containing sodium hydroxide solution. Carbon dioxide unites with the sodium hydroxide and is irreversibly removed from the atmosphere of the room. The scrubber is operated as needed to keep the carbon dioxide concentration at the desired level.

Controlled-atmosphere storage can add 4 to 6 months to the storage life of many apple varieties. Furthermore, after the apples are removed from this storage they remain marketable 10 to 20 times longer than similar fruit removed from regular cool storage.

Problems

Several serious disadvantages are associated with controlled-atmosphere storage which is developed by the respiring product. It takes about 3 weeks for apples to develop the desirable atmosphere. During the early part of this period the fruit respires quite rapidly. Highly perishable fruits and vegetables respire and deteriorate so fast that they are unacceptable before the desired atmosphere is reached.

Some apple varieties require different controlled atmospheres than others. This calls for separate storage rooms at a substantially increased cost. If the storage operator opens the door to the room, the controlled atmosphere is lost. Therefore he cannot go into the room to inspect or remove fruit until he is ready to empty the room. The storage room must be exceptionally well built and in a good state of repair to hold the gas generated by the respiring apples.

New development

A recent development has revolutionized controlled-atmosphere storage. Any desired atmosphere can now be developed instantly by burning natural or propane gas in a generator under precisely controlled conditions. The atmosphere is pumped directly into the storage room, so that the desired environment is provided with little or no delay.

Airtight storage rooms are not required; in fact, leaks are desirable. They allow a small amount of the controlled atmosphere to be forced out of the room, and this also removes some undesirable products, such as ethylene gas, which emanate from the apples.

Use of generators makes it possible to enter the storage room at any time to inspect or remove fruit. Generator cost and operation are economically feasible.

This new method offers many opportunities for expansion of controlled-atmosphere storage. The rapid development of a controlled atmosphere makes it possible to store highly perishable vegetables that could not be stored by the old method of letting the respiring product develop the controlled atmosphere.

Beans and broccoli stored

Controlled-atmosphere storage of vegetables is now being investigated in the Department of Food Science, University of Illinois. So far emphasis has been on broccoli and green beans. Several different atmospheres have been tried and found beneficial for these products. An atmosphere of 3 percent oxygen, 10 pecent carbon dioxide, and about 87 percent nitrogen, used in conjunction with normal refrigeration storage practices, has been especially effective.

The benefits of controlled atmosphere were more pronounced with broccoli than with green beans. Respiration rates of broccoli were reduced by about 40 percent when the oxygen content of the atmosphere was reduced to 2 or 3 percent, or when the carbon dioxide content was increased to 20 percent.

Yellowing of the flower heads, which is the most serious post-harvest quality loss in broccoli, was retarded by progressive increases in carbon dioxide and decreases in oxygen. It was clearly demonstrated that increased carbon dioxide, rather than decreased oxygen levels, substantially improved chlorophyll retention.

The effect of controlled atmosphere on color was not always noticeable in the raw product. After cooking, however, both heads and stalks of broccoli showed a marked improvement in color as a result of controlled-atmosphere storage.

Another interesting and desirable effect of controlled-atmosphere storage was a marked increase in tenderness of the broccoli stalk. The improvement in texture was directly correlated with an increase in pH and a decrease in titratable acidity of the stalk sap. This effect on texture was reversible, and the broccoli reverted to its original texture, pH, and titratable acidity about 24 hours after it was removed from controlled atmosphere.

Green beans in controlled-atmosphere storage did not fade in color as beans normally do during air storage. This advantage was noticeable in the raw product but was highly enhanced after cooking. Controlled atmosphere had no apparent effect on texture of green beans.

No significant differences in flavor were noted when broccoli and green beans stored in a controlled atmosphere were compared with those which had been stored in normal air. Controlled-atmosphere samples, however, could be held for a longer time than the air-stored products without noticeable deterioration in flavor.

The advantage for controlled-atmosphere storage of these products lies mainly in the retention of green color, and, in the case of broccoli, improvement of texture. Controlled-atmosphere storage should prove to be highly desirable for use with fresh produce and for holding vegetables prior to commercial freezing.

Are the stain-repellent textile finishes durable?

RUTH LEGG GALBRAITH and NANCY JOYCE

About a billion yards of fabric are now treated with fluorochemical finishes every year to make them resist both water- and oil-borne stains. Trademarks for the finishes now in use are Scotchgard and Zepel. They are especially valuable for wrinkle-resistant cottons, nylons, and the polyesters (Dacron, Fortrel, Kodel, and Vycron), which have a strong affinity for oily stains.

The durability of these finishes was recently tested in the textiles laboratory. We tried to find out whether abrasion caused by wear and laundering would fracture the repellent film on the fibers, allowing stains to penetrate to the fiber interior. We also tested the hypothesis that, if there were fractures, heat might heal them.

How study was conducted

Three wrinkle-resistant cotton fabrics were selected: a plain weave sailcloth sportswear fabric, a basket weave upholstery fabric, and a novelty weave upholstery or drapery fabric. The plain weave fabric was treated with one trademarked fluorochemical finish; the other two fabrics were treated with the second trademarked finish. The fabrics were all a shade of brown, ranging from beige to pumpkin. Each fabric was cut into 230 six-inch squares, so that five replicate specimens could be tested for every treatment.

Treatments consisted of all possible combinations of the following: no abrasion; two different types of abrasion, each at three levels of intensity; laundry (one or five cycles); no laundry; air drying; dryer drying; pressing; and no pressing. A completely randomized experimental design was used.

Fabrics were abraded with two types of laboratory abraders. In one, the fabric was rubbed while clamped onto a flat plate. This type of abrasion is similar to that sustained by upholstery fabrics during use. In the second abrader, the fabric was tumbled in a circular pattern, assuming many different configurations. Such abrasion simulates that which occurs when a fabric is free to move away from an applied force.

So that the small pieces of fabric would have a fairly normal agitation pattern during laundering, they were sewn to sheets in a random pattern. For laundering, we used a top-loading automatic washer; moderately soft water at a temperature of 135° F.; and a built controlled-sudsing detergent at a concentration of 0.2 percent based on weight of the water.

Half of the specimens were air-dried; the other half, tumble-dried in a dryer having an exhaust temperature under 175° F. One set of specimens for each treatment was then pressed for 10 seconds with a steam iron while a second set was left unpressed.

All specimens were then tested for their resistance to a water-borne stain (grape juice) and an oil-borne stain (the red oil from a non-emulsified French dressing). With a hypodermic syringe, 0.1 cc. of each staining medium was gently applied to the specimens. After 3 minutes, the grape juice and oil were carefully "wicked off" with tissues to avoid spreading the stains.

A panel of five rated the specimens for staining, using a 6-point scale. A score of 6 indicated no staining; 3, moderate staining; 1, high degree of staining plus spreading of the stain.

Results

Results for the basket weave upholstery fabric are given in the table. Since varying the type of abrasion had less effect than heating the fabric after laundering, stain repellency ratings for the abraded specimens are averages for the six abrasion treatments.

The plain weave fabric had lower repellency ratings after laundry and abrasion than did the basket weave fabric; the novelty weave had slightly higher ratings.

In all three fabrics, laundering and abrasion lowered the resistance to oil stains much more than the resistance to grape juice stains. The more a fabric was laundered or abraded, the greater was the loss of repellency. Abrasion plus laundering lowered stain resistance more than did either one alone.

Heating the fabrics after laundering markedly improved repellency. Pressing healed abrasion-caused fractures in the finish much more effectively than did drying in the dryer. After pressing, the air-dried and tumble-dried specimens had about the same repellency.

Effect of Laundry Procedures and Abrasion on Stain Repellency

Abraded	Times laundered	Type of drying	Pressed	Stain repellency ratings[a]	
				Water-borne	Oil-borne
No	0	None	No	6.0	5.9
Yes	0	None	No	5.3	3.9
Yes	0	None	Yes	5.5	4.7
No	1	Air	No	5.8	3.6
No	5	Air	No	6.0	2.2
Yes	1	Air	No	4.9	2.0
No	1	Air	Yes	6.0	5.5
No	5	Air	Yes	6.0	5.4
Yes	1	Air	Yes	5.1	4.6
No	1	Dryer	No	5.9	5.0
No	5	Dryer	No	6.0	4.0
Yes	1	Dryer	No	5.1	3.0
No	1	Dryer	Yes	6.0	5.5
No	5	Dryer	Yes	6.0	5.4
Yes	1	Dryer	Yes	5.1	4.7

[a] Rating scale ranged from 6, no staining, down to 1, high degree of staining plus spreading of the stain.

Ruth Legg Galbraith is Professor of Textiles; Nancy Joyce was formerly General Foods Fellow in Textiles and Clothing.

Longer life for chrysanthemum flowers

J. R. CULBERT

FOR SOME TIME florists have been regulating the growth of potted chrysanthemums by spraying the leaves with B-Nine (Alar), an organic chemical which shortens the internodes. Treated plants are not only shorter but also sturdier than untreated plants.

Now another benefit of B-Nine has been noted: It prolongs the useful life of the flowers. This effect was observed during early experiments in the Department of Horticulture and has been confirmed by later studies.

Plant at left was untreated. Center plant received one application of B-Nine at the rate of 5,000 p.p.m.; that on right received two applications. Although two applications did not decrease plant height much more than one application, they did further increase flower longevity.

Flower longevity demonstrated

Applications of B-Nine were varied in time, rate, and number to find the most effective combination for regulating chrysanthemum growth and prolonging flower longevity. Treatments were made on unpinched plants after short-day treatment was started to induce flowering.

Plants were shortened most effectively by one application at the rate of 5,000 p.p.m. (0.50 percent) made 2 to 3 weeks after the start of short days. Flowers on treated plants also lasted longer than those on untreated plants.

Additional applications at biweekly intervals did not shorten the plants much more than the single early application. However, flower longevity was further increased by spraying at 2 to 3 weeks after start of short days and again about 5 weeks later. Applications of 2,500 p.p.m. (0.25 percent) extended flower longevity slightly more than applications of 5,000 p.p.m.

The objective measurement of flower longevity was the elapsed time between loosening of the first ray floret from the bud and the first purpling of a ray floret. Chrysanthemums with white and yellow ray florets (flowers) first show age by a distinct color change of the florets to purple.

Neither plants nor flowers showed a change in weight due to the B-Nine applications. Stems and leaves of the treated plants were noticeably stiffer than those of untreated plants. Although this effect of the B-Nine applications could not be measured objectively, the plants were definitely sturdier than the untreated ones.

Further trials

Nine chrysanthemum pot plant varieties were treated and flowered in October and again in May. In all varieties, B-Nine reduced height and prolonged the life of the flowers. Considerable variation occurred, however, between varieties and according to time of year. Flower longevity was increased by 10 to 65 percent. Height reduction varied from as much as 40 percent to as little as 4 percent.

Flowers of a typical variety, Yellow Delaware, lasted for an average of 20 days when untreated plants were flowered in late October. When plants received a single application of B-Nine (5,000 p.p.m.) 2 weeks after start of short days, the flowers kept 24 days, or 20 percent longer than those on untreated plants. A second spraying of B-Nine at 2,500 p.p.m., 7 weeks after start of short days, extended flower longevity to 29 days, an increase of 45 percent over the untreated plants. Plants that were sprayed once were 10 percent shorter than the untreated plants; those sprayed twice were 17 percent shorter.

Recommendations

Present recommendations for producing short, sturdy chrysanthemum plants with flowers of increased longevity are as follows: Spray foliage of unpinched plants to run off, using 5,000 p.p.m. (0.50 percent) of B-Nine 2 to 3 weeks after start of short days. Spray pinched plants when the breaks are 1 to 2 inches long, depending on experience with the variety and the time of year. To further extend flower longevity, a second spraying at 2,500 p.p.m. (0.25 percent) may be made 7 to 8 weeks after start of short days or when the buds first show their true color.

J. R. Culbert is Associate Professor of Floriculture in the Department of Horticulture.

RESEARCH IN BRIEF

Sweet Corn Development Affected by Temperatures in the Seedling Stage

For a short time after corn begins to develop, the terminal growing point initiates one leaf after another until an unknown mechanism causes it to initiate the tassel. This change in the activity of the growing point fixes the number of leaves on the main stalk.

Variations in the number of leaves of sweet corn from one planting to another indicated that some environmental factor was influencing the stage of development at which this change took place. The erratic pattern of the variation within and between seasons suggested that something like temperature rather than day length was involved.

This possibility was investigated with Golden Cross Bantam plants. Two growth chambers were programed for a 14-hour light period and a 10-hour dark period. Temperatures in one chamber were held at 95° F. during the light period and 80° F. during the dark period. The corresponding temperatures in the other chamber were 75° F. and 50° F. Plants were put into these chambers for varying periods of time. They were then removed to complete their development under uniform environmental conditions.

Plants were little affected if they were exposed to the treatment before the fourth leaf appeared. The principal effects of treatment between appearance of the fourth and eighth leaves are shown below.

	Treatment	
	Cool	*Warm*
Leaves visible at time of tassel initiation....	6	9
Aver. number of leaves on main stalk........	14.6	17.7
Days from pollen shed to silk appearance....	4	0

These three observations form a consistent picture. Plants receiving the cool treatment initiated the tassel at an earlier stage of development than did warm-treated plants. With the early start, the tassels reached the stage of pollen shed sooner. There was no corresponding reduction, however, in the time required for silks to appear. This accounts for the 4-day spread between pollen shed and silk appearance.

Suckering response was not consistent. In one experiment, when plants were moved from the growth chambers to the greenhouse in early September, little suckering occurred. In a second experiment, plants were moved from the chambers to the field in late May. More suckering occurred on cool-treated plants than on warm-treated plants (see picture).

As part of the second experiment, some plants were left in the chambers for an extended period. When they were moved to the field, 12 leaves were visible on the cool-treated plants and 14 leaves on the warm-treated ones.

No additional effects were noted on plants receiving the extended cool treatment. Suckering was completely repressed on the warm-treated plants. They produced five or six small ears per stalk. Usually only 30 percent of Golden Cross Bantam plants produce two ears. — *C. Y. Arnold*

These plants were moved from the growth chambers to the field in May. More suckering occurred on the cool-treated plants (left) than on the warm-treated plants.

Pollen Germination Is Studied to Learn Causes of Sterility in Plants

Pollen germination and pollen tube growth are vital steps in the life cycle of higher plants. In nature, the growing pollen tubes penetrate the style, carrying the generative nuclei to the ovules where fertilization occurs. Sterility results when pollen tubes do not reach the ovules. For example, self-pollination is unsuccessful in some species because stylar tissue somehow inhibits pollen tube growth.

Another problem arises because geneticists often need to store pollen for shipment or for making pollinations at some future date. Pollen of many species loses its ability to germinate after a short period of storage. Species of the grass family are noto-

riously short-lived; corn pollen loses viability after only a week in storage.

To learn what prevents germination in these cases we must first understand the processes necessary for normal germination and tube growth. With this goal in mind, we recently began studies of lily pollen germination. The pollen germinates in flasks containing 10 percent sucrose and traces of mineral salts. Tube growth begins about an hour after pollen is placed in the sugar solution. The initial rate of respiration is relatively high, but drops by 50 percent after 30 minutes. The lower rate continues until tube growth begins. At that time respiration returns to a high level.

Studies with chemical inhibitors show that, during germination, respiration is controlled by the demand for metabolic energy. Thus the initial period of high respiration is an important stage of germination. This may be the time when necessary enzymes and membranes are synthesized in preparation for pollen tube growth. We hope that further studies will reveal the metabolic processes necessary for germination. — *David B. Dickinson*

Study of Toxic Compound Produced by Fungi Leads to Another Discovery

Many fungi cause diseases in plants and animals. Other fungi do not cause diseases but do produce compounds that are toxic to various plants or animals. For example, several recent cases of poisoning were reported in people who had eaten peanuts infected with the fungus *Aspergillus flavus*. Every year, also, several people develop ergot poisoning from eating bread made out of rye infected with the fungus *Claviceps purpurea*.

One particularly interesting compound, β-nitropropionic acid, is produced not only by several species of fungi but also by a number of higher plants. This compound is poisonous to animals that consume the plants which produce it. β-nitropropionic acid prevents the hemoglobin in the blood from binding oxygen, so the animals suffocate from lack of oxygen.

It is very difficult to study the origin of β-nitropropionic acid in higher plants. Since fungi are more readily grown in the laboratory, they are better organisms in which to study the synthesis of this compound. Various starting materials which contain radioactive carbon and others with heavy oxygen and nitrogen can be added to the fungus cultures to help us determine how fungi make β-nitropropionic acid. Thus far we have found that ammonia and certain organic acids normally formed from the breakdown of sugars are required for the synthesis of this toxic compound.

In the course of our work it became necessary to study the nitrogen metabolism of the fungi. One fungus, *Penicillium atrovenetum*, was found to have a nearly unique method for metabolizing nitrogen compounds. Although many organisms can grow with either ammonia or nitrate as a nitrogen source, this fungus is unusual in that it can convert ammonia to nitrate by a process called nitrification, and can also carry out the reverse process of denitrification. *P. atrovenetum* should therefore prove to be a good tool for studying the relationships between the different pathways of inorganic nitrogen metabolism by soil microorganisms. — *Paul D. Shaw*

Odors in Confinement Swine Buildings Are Analyzed and Evaluated

In recent studies of odors in hog finishing buildings, the emphasis was on buildings with solid floors. Some work was done in a slotted-floor building, however, and also around manure lagoons. Odor samples were collected in glass syringes and evaluated by a sniffing panel.

An experiment was performed in a solid-floor building to test the relationship of odor production to floor temperature and pig size (only growing and finishing pigs were tested). Ventilation rate and room air temperature were kept constant. No significant correlations were found. Odor dilution thresholds ranged from 2 to 7, indicating that odors in the building would diminish rapidly as ventilation rate was increased.

Ammonia was produced in the solid-floor building. The concrete floor surface seemed to contribute to this production, since there was ammonia in the building even after the pigs were removed and the floor was scraped clean. The continued presence of ammonia and odors suggested that the concrete surface might contain microscopic anaerobic digestion cells.

A gas collection cover was placed over a portion of a pen floor and concentrations of ammonia in the collector (with no ventilation) were compared with concentrations in the building atmosphere. The ventilation rate in the building was 20 c.f.m. per pig. At a floor temperature of 80° F. the concentrations of ammonia were 7 p.p.m. in the building atmosphere and 142 p.p.m. in the collector. At a floor temperature of 105° F. the concentrations were 15 to 21 in the building atmosphere and 176 in the collector.

Further identification of odors collected on filters along with dust was attempted. Gas chromatography and thin layer chromatography were used in conjunction with infrared spectroscopy in service laboratories. Several of the peaks of the chromatograms were identified as components of corn and soybeans, which would not account for the odors; but some very volatile short-chain elements were not identified.

Odors could be eliminated by bubbling them through distilled water and several chemicals, including oxidizing and reducing agents and basic and acidic solutions. Lagoon sludge odors could be dispelled by adding activated charcoal, used motor oil, and chlorine. Optimum application rates and length of effectiveness are not yet known. — *W. C. Hammond and D. L. Day.*

FARM BUSINESS TRENDS

CORN — which has long dominated the Illinois landscape as well as Illinois agriculture — is still growing in importance in the state.

Even with government acreage restrictions, corn occupies nearly half of the cropland in Illinois. The 9,114,000 acres harvested in 1964 was 45 percent of the total harvested acreage of crops.

Illinois ranks first among the states in sales of corn, though about two-fifths of the crop is fed to livestock on the farms where it is produced. Illinois farmers realized about $520,000,000 from sales of their 1963 corn crop. This was 40 percent more than the corn sales of any other state.

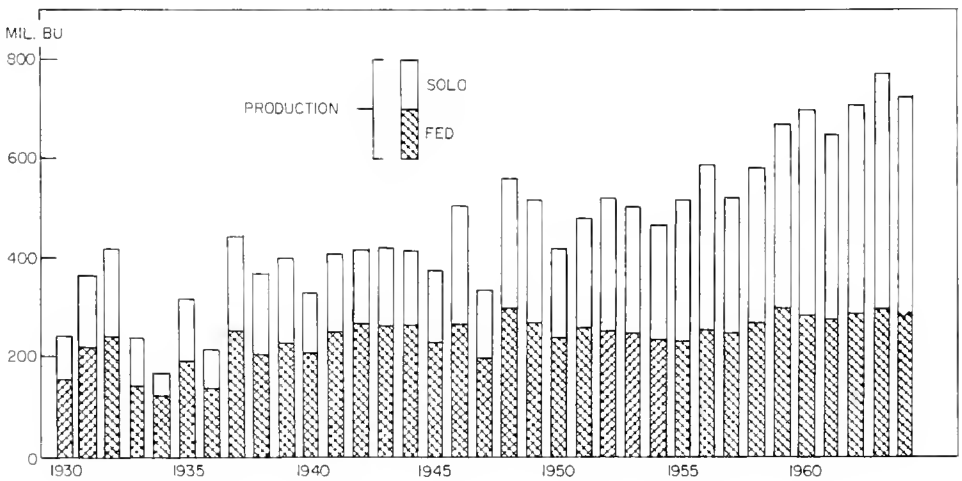
Corn is by far the biggest producer of income for Illinois farmers. Sales of corn produced 23 percent of all receipts from farm marketings in 1963. Comparable figures for other leading products were: cattle and calves, 20 percent; hogs, 19 percent; and soybeans, 17 percent.

These figures greatly understate the real importance of corn because much of the crop is fed to cattle, hogs, and poultry. Directly and indirectly, about 45 percent of all Illinois farm income is produced by the corn crop.

Corn production in Illinois first topped 400 million bushels in 1895 — 70 years ago. After that, no real increase in production was recorded for half a century. Corn production first exceeded 500 million bushels in 1946. During the past 10 years production has increased phenomenally. The present record of 752 million bushels was set in 1963. Last year's crop of 711 million bushels was the second largest yet produced.

Our five-year average production of corn is 691 million bushels, 81 percent more than 20 years ago. In this latest five-year period Illinois farmers produced 18.4 percent of the nation's corn. Twenty years ago they produced 14 percent, and 40 years earlier only 11 percent.

Most of the increase in corn production during the past 20 years has been sold for cash. The amount fed to livestock averages around 275 million bushels a year, only 10 percent more than 20 years ago. By contrast sales of corn now average 418 million bushels a year, nearly three times as much as 20 years ago.
— *L. H. Simerl*



CORN: Amounts produced, fed, and sold in Illinois, 1930-1964.

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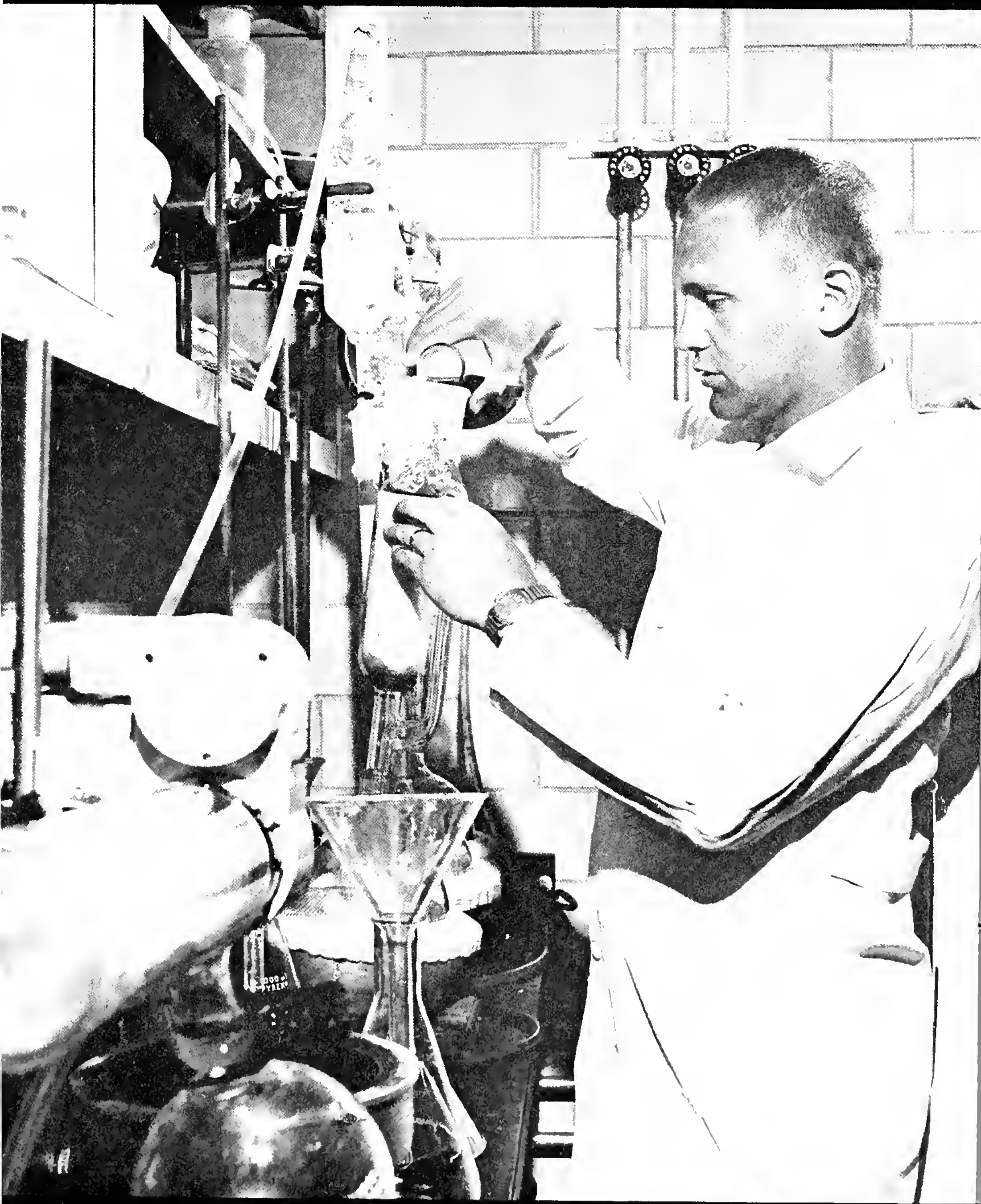

IN THIS ISSUE

Laboratory analyses are yielding information about the cause of slobbering in dairy cattle (page 6).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell . . . . Director

Adrian Janes . . . . Station Editor

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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NEWS AND VIEWS

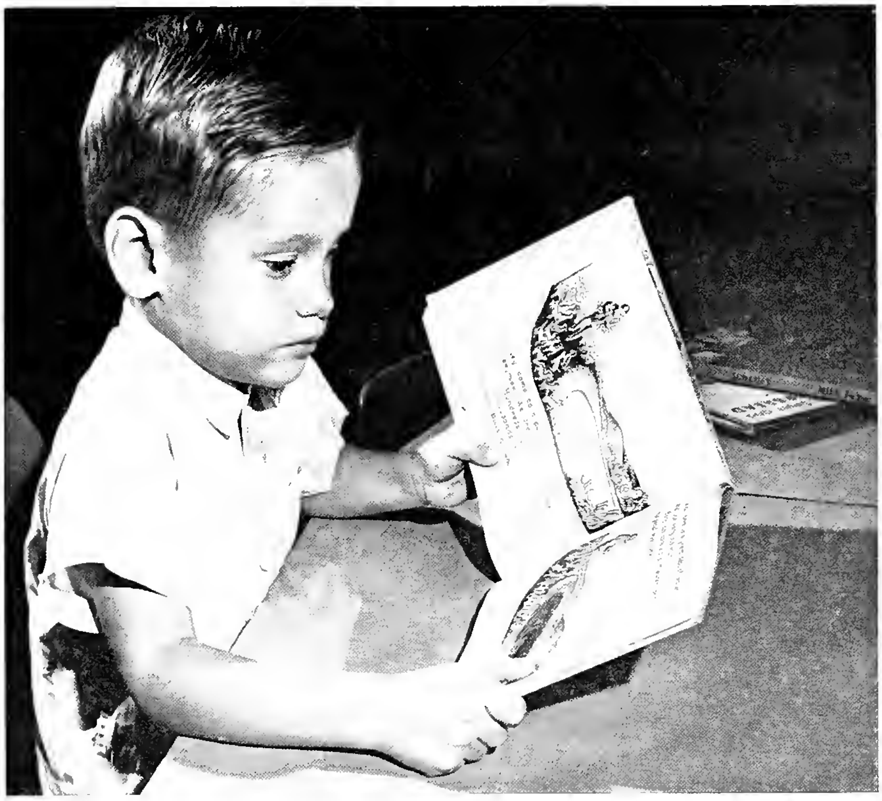
BECAUSE OF the rapid increase in agricultural production that has occurred in the United States during the past century, this nation can produce the food and fiber needs of its growing population and at the same time export increasing quantities of agricultural products to other countries. Consequently, we have been slow to recognize the magnitude and urgency of the current and projected food deficits in many other nations.

High birth rates and increased life expectancy are creating an unprecedented increase in world population. The "population explosion" is most alarming in those densely populated areas where the per capita supply of natural resources for food production is low and where low levels of literacy, political instability, and shortages of capital pose serious obstacles to the rapid adoption of improved technology for increasing food production.

Since the U.S. Department of Agriculture and the land-grant universities were established just over a hundred years ago, they have contributed greatly to the growth and transformation of U.S. agriculture. As these institutions enter their second century, they are faced by another even more difficult task, just as important for this country as the one they so successfully attacked during the past decades. The task was recently well defined by Dr. Ervin J. Long of AID: "This is the challenge which destiny now gives the USDA and the American land-grant universities: to provide the underdeveloped countries the foundation of knowledge upon which to build a productive and prosperous agriculture, within a structure of institutions which will direct their social and political development toward freedom, peace and democracy."

It is in response to this challenge that we at Illinois are joining our colleagues from other institutions to help establish and nurture agricultural teaching, research, and extension programs in India, Sierra Leone, Jordan, and other countries where hunger and want are major barriers to the realization of human aspirations and national goals. — *M. B. Russell*

After writing this article in early September, Dr. Russell left for India, where he will serve for 3½ months as special adviser at Jawaharlal Nehru Agricultural University.



Some children move right into books . . .

. . . others are more fascinated by letters

Should Preschool Children Be Taught To Read?

QUEENIE B. MILLS and ALICE RUTH MISCHKE

Ever since Sputnik went into orbit, many Americans have been demanding that our elementary schools and high schools teach more subject matter. This demand for an expanded curriculum has naturally raised a question as to when a child should learn to read. Do we need to delay reading instruction until the traditional age of six?

In the past, children who learned to read before they entered the first grade were considered exceptional. Now, however, individual and group methods of teaching reading to preschool children are being widely investigated. Many educators, enthusiastic about the results of these early-reading studies and anxious to speed up academic achievement, are starting the formal teaching of reading at the kindergarten level. Some advocate that even younger children be taught to read at home or in nursery school.

On the other hand, many are expressing doubts about the wisdom of accelerating reading instruction. Although it has been demonstrated

Queenie B. Mills is Associate Professor of Child Development, Home Economics Department; Alice Ruth Mischke was formerly an Assistant in Home Economics. This paper is based on a graduate study that Mrs. Mischke did under Dr. Mill's direction.

that some children can easily start reading when they are four or five, we still don't know whether the average learner can do so. And even if he *can* start, *should* he? What price might we have to pay for early readers? Critics of the early-reading program contend that all possible negative effects should be explored before reading is generally introduced at the preschool level.

One concern is that preschool reading may lead to later eye trouble. So far surprisingly little work has been done on individual differences in visual readiness for reading instruction.

We need to keep continuing records on children who have learned to read at three, four, and five years of age, to learn whether their vision as adults has been in any way impaired. For the present, however, we shall have to rely largely upon the clinical observations of experts.

Ophthalmologists questioned

To get the benefit of expert opinion, a survey of Illinois ophthalmologists was sponsored by the Division of Child Development of the University of Illinois. The main question we had in mind was: What is the earliest recommended age at which the normally developing child should begin reading instruction?

Underlying the question were three others: What levels of visual development should the child reach before he starts to read? Will physical dysfunctions or difficulties result if reading instruction is begun before visual readiness is achieved? What are the sources of information upon which ophthalmologists base their opinions about visual development?

Questionnaires were mailed to 232 ophthalmologists. These were all the Illinois members of the American Academy of Ophthalmology as listed in the 1963 directory of the academy. Ophthalmologists were chosen as the source of expert opinion because they are physicians who have specialized in the structure and functions, as well as the disorders and diseases, of the eye. The entire Illinois membership of the academy was questioned to ensure adequate representation from all sections of the state.

Of the 232 ophthalmologists, 162 or 69.8 percent responded in some way to the questionnaires; and 140, or 60.3 percent of the questionnaires contained usable information.

Opinions differ

Over half (59.6 percent) of the ophthalmologists believed that a four-year-old child was not too young to begin reading instruction; 27.2 percent suggested waiting until the child is at least five years old. Only 12.5 percent thought it necessary to delay reading instruction until the traditional age of six.

Although 83.8 percent of the respondents indicated that preschool children could start learning to read, this group did not necessarily believe that these children had *optimum* visual readiness. Nearly half (45.6 percent) of the ophthalmologists believed that a child did not reach optimum readiness before the age of six. Unfortunately, we cannot determine the extent to which the thinking of these opthalmologists has been influenced by traditional educational practice.

For the most part, clinical experience and observation, along with professional training, formed the bases of the ophthalmologists' opinions as to visual readiness for beginning reading instruction.

The age recommended for earliest exposure to reading was significantly influenced by the ophthalmologists' opinions as to when children achieve good coordination of their two eyes. Most eye specialists consider that binocular coordination is stabilized before children are six and that the task of reading actually speeds the process.

Some of the ophthalmologists pointed out that hyperopia or farsightedness is natural in the young child and that this condition is not outgrown before the age of six. A preschool child thus has to compensate for some degree of farsightedness when he is reading a book. His eyes are less likely to tire if blackboard reading is alternated with book reading.

As some children approach adolescence, they develop myopia or nearsightedness. The ophthalmologists indicated that this is due to physiological growth determined by heredity rather than to close visual work.

In general, the specialists believed that visual dysfunctions will not usually be precipitated just by preschool reading, even if reading is introduced before the child has achieved visual readiness for the task.

A functional examination before the age of six was generally recommended. Such an examination would ascertain the child's level of visual development and would also pinpoint any special problems that need correcting. It would be well to consider a specialist's evaluation of a child's visual readiness before deciding to introduce reading during the preschool years.

Other desirable studies

Seemingly it would be worthwhile to compare the opinions of optometrists with those of ophthalmologists. Judging from the literature, optometrists have been more active than ophthalmologists in research on reading as related to vision in preschool and school children. Ophthalmologists, however, because of their medical background should be more aware of the visual dysfunctions, if any, that might result from the demands of early reading instruction.

A long-time study is necessary to arrive at a reliable and valid conclusion regarding the effects of early reading instruction on the child's vision. A group of children who have been taught to read early should be followed for a number of years. Vision specialists, pediatricians, and child development specialists should be intimately involved in the design, execution, and evaluation of such a study. Only then will some of the questions posed in this study be answered with any degree of assurance.

RYE OR RYEGRASS FOR WINTER COVER:

Effect on Yields of Following Corn Crop

C. H. FARNHAM, P. E. JOHNSON, and J. W. PENDLETON

On level Illinois land, long crop rotations which include spring oats and small-seeded grasses and legumes are receiving less emphasis than in the past. The present trend is toward more intensive systems centering around corn and soybeans.

Many Illinois farmers are interested in the use of winter cover crops in these intensive rotations. Several annual legumes may be used for this purpose farther south, but they are not generally adapted to Illinois. Two crops that are adapted are rye and ryegrass. They are winter-hardy and relatively tolerant to late seeding and a poor seedbed.

Will these crops yield enough to justify the costs of seed, fertilizer, and planting? Two long-time experiments have provided some answers to this question. The experiments were conducted on a dark soil (Drummer) at Urbana and a light soil (Cisne) at Newton. Both trials were located on level prairies where erosion was not serious.

On the highly productive soil at Urbana, corn yields in a continuous-corn system were not increased by interseeding a winter rye cover crop during late summer (Fig. 1). In fact, without the addition of nitrogen, the rye interseeding decreased corn yields by 9 percent. Where 100 pounds of nitrogen, 22 pounds of phosphorus (50 P_2O_5), and 42 pounds of potassium (50 K_2O) were applied annually, corn yields on the rye-interseeded plots increased by 43 percent. This increase, however, was no better than that on similarly fertilized plots without rye. (Fig. 1).

At Newton, interseedings of rye or ryegrass, without nitrogen fertilizer, decreased corn yields in a continuous-corn system (top, Fig. 2). When 140 pounds of nitrogen were added annually, corn yields increased substantially with either species, but did not surpass the yields from plots without a cover crop.

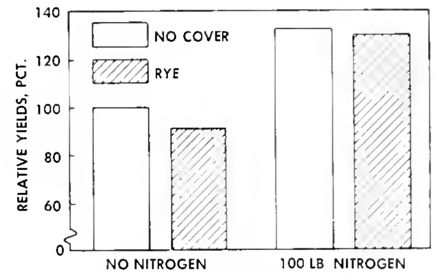
The lower part of Figure 2 shows corn yields when rye and ryegrass were interseeded in a corn-soybean rotation. Neither cover crop, with or without nitrogen, increased yields over those on the unseeded plots.

A comparison of the upper and lower parts of Figure 2 indicates the favorable nitrogen relationship resulting from soybeans in a rotation. Application of 140 pounds of nitrogen increased corn yields by 60 to 80 percent in the continuous-corn system, but by only 15 to 30 percent in the corn-soybean system.

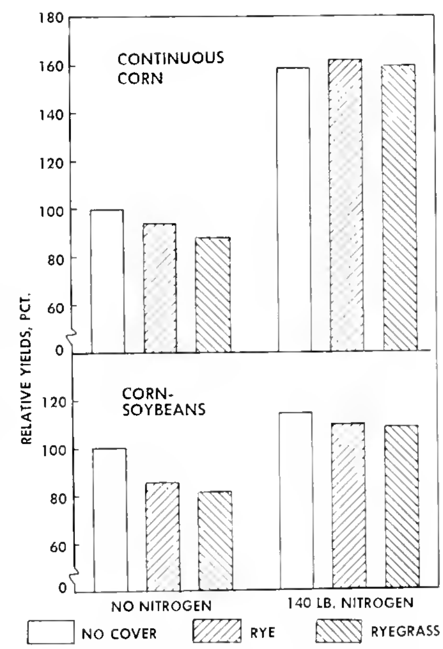
The results at Newton and Urbana suggest that the use of cover crops depends on other objectives than increasing corn yields. Cover crops might be used to control erosion on sloping areas, for example, or to provide late-winter or early-spring grazing for livestock. The trials reported here were conducted on relatively level land, and the cover crop was not used for forage.

Several practical problems will arise with use of winter cover crops. While rye or ryegrass can be easily seeded after soybean harvest, corn is often harvested too late to permit good establishment and growth of rye. Seeding rye in standing corn in late summer requires special techniques, such as the use of airplanes or "Hi Boy" type implements. Such seedings are often disappointing in dry falls, particularly in southern Illinois. Stands and winter cover were rated excellent in only 5 years out of 13 in the Newton trials.

Another problem with rye is its tremendous growth rate at about the "boot" stage. While this adds total dry matter for plowing under, it may necessitate field chopping before plowing. Also stored soil water can be reduced, both by the crop's requirements during this grand period of growth, and by evaporation from the rough porous soil after plowing.



Effect of a rye winter cover crop on corn yields in a continuous-corn system, with and without nitrogen fertilizer. Urbana, 1953-1959 average. (Fig. 1)



Relative yields of corn in a continuous-corn system and a corn-soybean rotation following winter cover crops of rye and ryegrass, with and without nitrogen fertilizer. Newton, 1953-1964. (Fig. 2)

C. H. Farnham is Assistant Professor of Crop Production and Soil Fertility; P. E. Johnson, Assistant Professor of Soil Fertility; and J. W. Pendleton, Professor of Agronomy.

How Moldy Feeds Cause Slobbering

S. D. AUST and H. P. BROQUIST

THE POISONING caused by contaminated feeds is a major hazard to the livestock industry, particularly the dairy business.

A great deal has been said lately about feed contamination resulting from the indiscriminate use of insecticides. Perhaps less attention has been given to a more subtle type of contamination — that caused by fungi or molds.

Fungi compose a large class of lower plant life which can grow on very simple compounds but produce surprisingly complex organic molecules. Some of these molecules, like citric acid and riboflavin, may be valuable foods. Others are life-saving antibiotics — for example, penicillin and aureomycin. And still others are poisons. These include the ergot alkaloids and dicumarol, a potent anticoagulant and the cause of spoiled sweet clover disease.

Infestation of corn and various forages by molds can lead to dire consequences. In the spring of 1962, several heifers at the University dairy farm died from massive hemorrhaging after eating a certain lot of ground corn. Later the corn was shown to have been heavily infested with the mold *Aspergillus flavus*, which produces several different groups of toxic materials.

Another mold has been found to cause excessive salivation or "slobbering." For a number of years, the Experiment Station has received reports of slobbering in animals after they had consumed certain forages. Most often these animals were dairy cattle or horses that had eaten second-cutting hay or silage made from red clover or alfalfa.

Such slobbering has been reported throughout the Midwest as well as in some eastern states. The animals' reactions have always been the same: After one to three feedings of the slobber-causing forage they have salivated excessively and then refused to eat any more of the forage.

Salivation factor in fungus

By 1958 reports of excess salivation in this state were so numerous that the Department of Dairy Science began hunting the specific cause. Over a period of several years, attempts were made to isolate the salivation factor, SF, from hay. It was established that this factor was a water-soluble, heat-stable organic substance and that its physiological effect might be related to the action of acetylcholine (a body product involved in salivation).

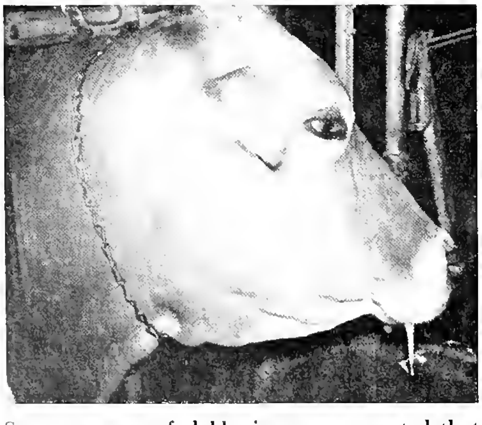
In August, 1962, workers at the University of Wisconsin reported that slobber forages were infested with a dark brown fungus mycelium and that this fungus, rather than the red clover plant itself, was responsible for the factor causing the slobbering. They identified the fungus as *Rhizoctonia leguminicola,* which causes black patch disease of red clover.

SF purified

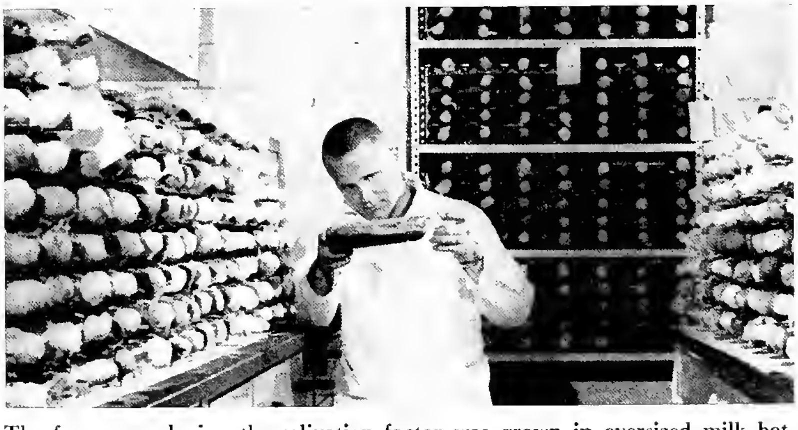
Since this discovery, we at Illinois have been learning more about the fungus and the way it stimulates salivation. A pure culture of the fungus was obtained from Dr. G. W. Gerdemann, Department of Plant Pathology, and was maintained on potato-dextrose-agar slants. When grown on a cold-water extract of red clover hay, the culture produced large amounts of SF.

To have enough SF for further study, the fungus was grown in oversized milk bottles. After the mycelium (mat of mold growth) was harvested, SF was isolated from it. As the SF was being extracted from the mycelium, the quality of each batch was tested by injecting part of it into guinea pigs and observing the degree of salivation at 15-minute intervals. This crude biological assay

S. D. Aust is Research Assistant in Dairy Science; H. P. Broquist is Professor of Biological Chemistry, Dairy Science Department.



So many cases of slobbering were reported that scientists began hunting the cause. (Fig. 1)



The fungus producing the salivation factor was grown in oversized milk bottles. Here Mr. Aust examines one of the mold cultures. (Fig. 2)

was then used as a guide in fractionation, or purification of the SF.

After purification, the behavior of SF, together with certain of its chemical and physiological properties, strongly suggested that it is an organic base belonging to that group of natural products known as alkaloids.

Molecular structure studied

Much of our present research consists of chemical and physical studies aimed at learning the exact chemical structure of the SF molecule. Such information is necessary for several reasons. One is that, when the structure is known, we will be able to synthesize it chemically instead of extracting it by the laborious biological method now used. We will then have all the material we need to conduct physiological studies in various animal systems.

Knowing the structure of the SF molecule would have a second big advantage: It should suggest experiments that might reveal the way in which the mold synthesizes the alkaloid. For example, the mold could be grown in a synthetic medium with test radioactive precursors, the SF isolated, and radioactivity measured. Later chemical breakdown would reveal the exact location of the radioactive material. In this manner, we might ultimately construct the exact way in which SF is formed. This knowledge, in turn, might tell us something about alkaloid biosynthesis in higher plants — a process about which very little is now known.

SF causes viscous saliva

Detailed studies of the physiological action of SF and its effects on salivation have been undertaken with the cooperation of Dr. I. Parnas, Department of Physiology and Biophysics.

Salivation is induced by two nervous systems: The cholinergic (parasympathetic) system causes a viscous secretion; the adrenergic (sympathetic) causes a watery type of saliva. Acetylcholine is released by the cholinergic system; adrenalin by the adrenergic system. Both are destroyed by enzymes in the body. Acetylcholine esterase is the enzyme destroying acetylcholine.

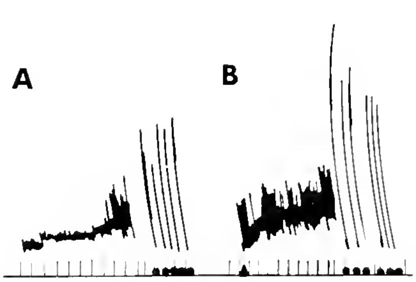
When saliva of cows fed slobber hay was analyzed, it was found to be a viscous type. This suggested that SF was acting through the cholinergic system. The question, however, was "How?" One possible answer might be that SF was inhibiting the action of acetylcholine esterase. When the enzyme was studied in the laboratory, however, SF did not block its action.

SF heightens sensitivity

Other possible mechanisms by which SF affects a cholinergic system were studied, using the smooth muscle of the guinea pig intestine. This muscle was chosen as a model cholinergic system.

Sections of the ileum (part of the small intestine) were incubated in an appropriate physiological solution. Muscular action before and after various treatments was monitored through a tension transducer. This device records the contraction of a muscle by means of a lever that writes on a revolving drum.

Figure 3 shows part of the record made by the tension transducer. In Part A, we see the spontaneous action of the ileum for a 10-minute control period with no treatment and then the response to a small test dose of acetylcholine. Part B shows what happened after the ileum was incubated with SF. The SF caused a slow, erratic spontaneous contraction that was stronger than during the control period. The ileum was washed and the same amount of acetylcholine was added as in Part A. Contractions after this second dose were much stronger than after the first dose.



Effect of slobber factor (SF) on guinea-pig ileum preparations. Vertical marks along base line indicate minutes. Circles indicate 0.25 mμg. acetylcholine per ml.; triangle, 25 mμg. SF per ml. (Fig. 3)

It first appeared that two separate phenomona accounted for the two effects of SF — the increase in spontaneous contraction before the acetylcholine was added and the augmented response to the addition of acetylcholine. Another possibility, however, needed to be investigated. This was that both responses were due to a heightened sensitivity to acetylcholine, whether it was the internal acetylcholine causing spontaneous contractions or the acetycholine added in the test dose.

Since morphine inhibits the release of internal acetylcholine in the guinea pig intestine, an experiment was devised wherein morphine was incubated with the ileum before SF was added. No spontaneous contractions were observed after addition of SF. When a test dose of acetylcholine was added, an augmented response like that in Figure 3, Part B, was still observed. It was also found that atropine, a compound which inhibits the action of acetylcholine by binding its acceptors, would counteract the action of SF. From these data it seems reasonable to conclude that SF somehow increases the sensitivity of these acceptors to acetylcholine.

Varied results of research

The research on the applied problem of slobber hay has led to the discovery of a new alkaloid with a unique physiological function.

On the practical side, slobbering in ruminants has been clearly found to result from mold contamination of a forage crop. This discovery has emphasized the need for more research on growing and handling farm crops to minimize such infestation.

At the same time, the discovery has raised more basic questions concerning the biogenesis of the alkaloid and its physiological action, the answers to which must await further research.

1985: What Will the Population of Illinois Be Then?

C. L. FOLSE

THE POPULATION OF ILLINOIS is still growing, but not as fast as between 1950 and 1960.

From the last census of population in April, 1960, until July 1, 1963, there were 759,000 births and 337,000 deaths among Illinois residents, resulting in a natural increase of 422,000. During the same period an estimated 121,000 more people moved out of the state than moved in, so that the net increase was about 301,000. Total population on July 1, 1963, was about 10,382,000.

During the 39-month period the population increase amounted to 0.9 percent per year. From 1950 to 1960 the annual increase was 1.5 percent. White population increased by 2.4 percent during the 39 months, for an average annual rate of 0.8 percent; nonwhite population increased by 8 percent, or about 2.5 percent a year. From 1950 to 1960, white population increased by about 1.2 percent a year and nonwhite by about 6 percent.

Changing migration

The changing pattern of migration was the main cause for the slower growth. In the 1950-1960 decade, 189,000 more nonwhites moved into the state than out of the state, while 64,000 more whites moved out than moved in. This resulted in a net in-migration of 125,000 for the 10 years, or 12,500 a year. By contrast, Illinois had a net out-migration of 36,000 a year between April, 1960, and July 1, 1963.

The average annual out-migration of whites during the 39-month period (35,000) was more than five times as great as during the 1950-1960 decade (6,400). As a matter of fact, the loss in 3¼ years was almost double that of the previous 10 years.

Even more dramatic is the fact that nonwhite migration was completely reversed during the more recent period. From an annual net gain of 18,900 in the 1950-1960 decade, it dropped to an annual loss of 1,000. The importance of this reversal is perhaps best illustrated by the fact that from 1940 to 1960 Illinois gained about 417,000 nonwhites through migration — more than the total nonwhite population enumerated in the 1940 census. Although a decline was anticipated in the number of nonwhites coming into the state, the complete reversal was unexpected. The increased rate at which whites have been leaving the state in recent years and the reversal of nonwhite migration are not easily explained.

Recent patterns of migration in Illinois follow those of other selected North Central states. Losses through migration for Ohio (120,000), Indiana (88,000), Michigan (178,000), and Wisconsin (78,000), together with those for Illinois, amounted to more than half a million people between April 1, 1960, and July 1, 1963. Each of these states except Wisconsin showed net losses of nonwhites through migration, reversing the 1950-1960 pattern. Only Illinois and Wisconsin showed a net loss of white population in the 1950-1960 decade.

New projections for the future

The changing patterns of migration, together with increasing evidence that birth rates have declined, suggest that previous projections of future population have been too high for many states. Revised projections of population for each state, 1970 to 1985, have been made by the Bureau of the Census in a February, 1965, report.

C. L. Folse is Professor of Rural Sociology, Departments of Agricultural Economics and Sociology.

Four influences have to be considered in population projections: births, deaths, migration between the states, and immigration from abroad.

In the census report, it was assumed that out-migration and in-migration for the different states would continue at the 1955-1960 rate. Such an assumption is bound to be uncertain, as illustrated by the dramatic change in the migration pattern for Illinois since 1960.

It was also assumed that about 300,000 immigrants from abroad would arrive in the United States each year of the projection period. The number allocated to each state was based on the number of foreign-born in 1960 who reported their residence as abroad in 1955.

The death rate is fairly stable and fairly easy to predict. Average life expectancy at birth in 1960 was 66.6 years for males and 73.6 years for females. According to a recent estimate by the Social Security Administration, life expectancy in 1985 will be 68.0 and 74.5 years for males and females, respectively. Thus, in the 1960-1985 period, life expectancy will probably increase moderately. The annual death rate during the period will be between 9 and 9.5 per 1,000.

The number of births are harder to predict, particularly over extended periods, because social, economic, or political conditions may alter the birth rate. The recent census report makes two projections for each state, using different assumptions regarding the birth rate.

One projection — series B — is based on moderate fertility throughout the projection period. It is assumed that each 1,000 women of child-bearing age will have 3,100 children by the time they have com-

pleted child-bearing. In the other projection — series D — it is assumed that fertility will decline markedly and that each 1,000 women will bear 2,450 children. The projected populations for Illinois for the two series are as follows:

Year	*Series B*	*Series D*
1970	11,163,000	10,997,000
1975	11,971,000	11,596,000
1980	12,933,000	12,283,000
1985	13,997,000	13,017,000

Between 1950 and 1960 Illinois population increased by more than 1.3 million, or 1.5 percent a year. This was the largest increase during an inter-census period since the first federal census was taken. Under the moderate-fertility assumption, Illinois population will increase by 3.9 million or 38.8 percent from 1960 to 1985. With the low-fertility assumption the increase will still be a sizable 2.9 million (see table below). Average annual growth will be about 1.6 percent under the B series projection; 1.2 percent under the D series.

Rural vs. urban population

Projecting the proportions of rural and urban population in Illinois is rather difficult. We can do this, however, by assuming that the process of urbanization, already pervasive, will continue in the future. Only the series B projection is used since we are interested in the proportions of the total population in rural and urban areas, rather than their absolute numbers. If the actual population follows the series D projection, the proportions will be the same as in the B series.

It is assumed that the rate of change in the proportion of rural and urban population that took place between 1950 and 1960 will continue. It is further assumed that the Bureau of the Census will not radically change its definition of urban.

From 1950 to 1960 the proportion of the total population classified as urban increased by 3.1 percent. If the same rate of change prevails from 1960 to 1985, the proportion will increase by 7.8 percent, resulting in a population that is 88.5 percent urban and 11.5 percent rural.

If we apply these percentages to a total population of 13,997,000 (the series B projection for 1985) then we will have an urban population of 12,387,000 and a rural population of 1,610,000. Urban population would increase by 4.25 million, or 52 percent over the 1960 count, and rural population would decline by about 330,000, or 17 percent.

Perhaps the most significant recent trend in the distribution of the state's population has been the increasing concentration in metropolitan-urbanized complexes. In 1950, such complexes included 79 percent of all urban residents; in 1960, 82.5 percent. If the same change in proportions continues until 1985 the urbanized metropolitan complexes will contain 90 percent (11.1 million) of all urban residents, and cities outside of the metropolitan areas would have 1,287,000.

Projected Population Increases Over the Preceding Period

Period	Series B		Series D	
	Number	Pct.	Number	Pct.
1950-60	1,369,000	15.7	....	.
1960-70	1,082,000	10.7	916,000	9.1
1970-80	1,770,000	15.9	1,286,000	11.7
1960-85	3,916,000	38.8	2,936,000	29.1

Rural farm vs. nonfarm

It is much more difficult to project the rural population into its farm and nonfarm components than to project the urban groups. The chief problem is that there is no realistic basis for assessing the trend in number of farms. How many farms we have in the future will depend largely on the rate of technical innovations and on developments in agriculture and the economics of production.

It is reasonable to assume that the number of farms will not decrease as fast as between 1940 and 1960. It is also highly probable that sometime in the near future the total number of farm units will stabilize at some optimum level. Quite a bit of crystal-ball gazing has been done in this area, as a result of which we assume that there will be about 100,000 farm units in 1985. If this proposition is tenable, about 360,000 people will be living on farms. The number of farms will be about one-third less than in 1959 and the farm population about 36 percent below that of 1960.

Since farm population declined by about 405,000 between 1940 and 1960, a decrease of 203,000 between 1960 and 1985 does not appear improbable. The rural nonfarm population would thus number about 1,250,000 in 1985 — somewhat less than the 1,378,000 in 1960. Thus, of the total decline in rural population over the 25-year projection period, two-thirds would be among farm residents and one-third, nonfarm residents.

Not a prediction

It is important to remember that the figures given here are not forecasts. They are merely projections based on several assumptions regarding deaths, births, and migration — the major demographic variables that influence population growth and distribution.

The death rate is not likely to change as much as the other two variables, unless some major medical breakthrough markedly reduces the number of deaths from heart diseases and cancer, which now account for three-fifths of all Illinois deaths. Birth rates and migration patterns may be highly variable, depending on political, economic, and social conditions that nobody can foresee.

The Bureau of the Census states that its projections "are based on the assumption that there will be no disastrous war, widespread epidemic, or similar catastrophe. It is further assumed that there will be no major economic depression: in fact, the projections are designed to be consistent with high economic activity."

Even with all the limitations of population projections, a well-made estimate is obviously better than a biased guess or no estimate at all.

Aerial view of the 4-H camp and the forest plantations north of the camp buildings. Windbreak planted in 1947 is shown at far left.

FOREST PLANTATIONS at 4-H Camp Give Both Information and Enjoyment

RALPH W. LORENZ

FOREST plantations begun nearly 20 years ago have changed the scene at the State 4-H Memorial Camp and are adding to the enjoyment of camp life.

These aren't the only benefits. The plantations, which include a wide variety of conifers and hardwoods, are providing valuable information on the growth and performance of the various species. Club members are using the area as an outdoor laboratory where they can learn how to establish and care for forest plantations. And the trees are helping to keep the soil from washing into the camp lake.

The 4-H Memorial Camp is just north of Allerton Park, which is near Monticello in Piatt County. When Robert Allerton gave the park to the University in 1946, he also gave 250 acres to be developed and maintained by the University for the 4-H Club and related educational programs. Much of the area had been under cultivation for years.

Planting and early care

Eighteen 2-acre square blocks were planted to forest trees during 1947 and 1948. These blocks are shown in the aerial photograph, and have been numbered for easy reference to the table, which gives growth data for each species.

In addition to the 18 blocks, a windbreak ½ mile long was planted along the west boundary road in 1947. It contains 11 species of conifers. Other plantings have been made almost every year. An especially large planting was made in 1961: Mixed hardwoods and conifers were planted on some 30 acres west of the lake to provide a scenic woodland area.

By now, most of the area north and west of the lake, comprising about 100 acres, has been planted. This area will be completely planted in the near future.

Tree improvement studies were started in 1961. Japanese larch seedlings from seven different seed sources were planted, and a heritability study of Scotch pine was begun, involving 140 progeny groups from Belgium, Germany, and the Scandinavian countries. In 1962 a range-wide study of red oak comprising 32 separate seed sources was established, and hybrids of pitch pine × loblolly pine were planted. Next spring Douglas fir seedlings from 50 separate seed sources will be planted along the north boundary.

Korean lespedeza was sown at the time of the first plantings, but it did not suppress the rank growth of giant foxtail, ragweed, wild lettuce, velvet weed, and other weeds that typically develop on fallow land in this area.

Climate and soils

Piatt County has about 175 frost-free days. Annual rainfall averages 37 inches, much of it being distributed throughout the growing season.

Average monthly temperatures drop below 32° F. in December, January, and February, with January usually being the coldest month. The plantations were subjected to a temperature of —15° F. on February 2, 1951. In January, 1959, they underwent the worst ice storm recorded in east-central Illinois in 50 years. The ice did not appreciably damage jack, red, and white pines, but it broke the tops of 30 percent of the short-leaf and loblolly pines.

Most of the soil occupied by the plantations is classified by the Illinois Soil Survey as Sunbury silt loam (No. 234). This grayish-brown soil is a

Ralph W. Lorenz is Professor of Forestry.

transition between Gray-Brown Podzolic forest soils and Brunizem soils. The more depressional soils are mostly Drummer silty clay loam (No. 152).

How the species are doing

Diameter and height of 10 conifers and 10 hardwoods in the oldest plantations are given in the table. No data are given for the more recent plantings. The various species are discussed below in the same order that they appear in the table.

Growth Data for Tree Species in the State 4-H Memorial Camp Plantations

	Plantation number and tree species	Age class of nursery stock, yrs.	Plantation age, yrs.	Trees per acre	Average diameter breast high, in.	Average height, ft.
1	Jack pine (*Pinus banksiana*)	2-0	16	1,064	3.7	23.7
2	Osage-orange (*Maclura pomifera*)	1-0	16	830	.	8.8
3	Silver maple (*Acer saccharinum*):					
	Slopes	1-0	16	480	1.7	13.0
	Draw	1-0	16	650	2.9	31.0
4	White oak (*Quercus alba*)	1-0	15	465	2.6	15.2
5	Tuliptree (*Liriodendron tulipifera*)	1-0	16	*	3.1	21.1
6	Pitch pine (*Pinus rigida*)	2-0	16	884	4.6	24.0
7	Red pine (*Pinus resinosa*)	2-2	16	907	4.7	22.2
8	Eastern cottonwood (*Populus deltoides*)	1-0	16	372	3.9	22.5
9	Black walnut (*Juglans nigra*):					
	Slopes	nuts	15	572		5.3
	Draw	1-0	16	613	4.6	29.3
10	Japanese larch (*Larix leptolepis*)	3-0	15	*	4.9	26.1
	Norway spruce (*Picea abies*)	2-2	13	*	3.3	17.8
11	Red oak (*Quercus rubra*)	1-0	15	357	2.6	15.2
12	Shortleaf pine (*Pinus echinata*)	1-0	16	612	4.8	27.4
13	Eastern white pine (*Pinus strobus*)	2-2	16	918	5.0	27.3
14	Green ash (*Fraxinus pennsylvanica*)	1-0	16	481	3.5	22.0
15	Sweetgum (*Liquidambar styraciflua*):					
	Slopes	1-0	16	604	2.2	15.1
	Draw	1-0	16	594	4.1	26.4
16	American sycamore (*Platanus accidentalis*)	1-0	15	395	1.8	14.2
17	Loblolly pine (*Pinus taeda*)	1-0	16	858	5.4	37.3
	Baldcypress (*Taxodium distichum*)	1-0	17	*	2.6	14.4
18	Virginia pine (*Pinus virginiana*)	1-0	16	715	5.1	31.1

* Scattered trees only, due to poor survival.

1. **Jack pine** in these plantations is limby with poor form. In central and northern Illinois, it does better on the lighter-textured soils.

2. **Osage-orange** is a hedge species that Jonathan Baldwin Turner made famous in Illinois in the mid-nineteenth century. Mice and rabbits severely damaged the plantation at an early age. Trees are extremely crooked and growth is slow.

3. **Silver maple** was severely injured by mice at an early age. It made excellent growth in the draw, but failed on the upper slopes.

4. **White oaks** are mostly sprouts originating from seedlings clipped by rabbits. Growth is slow.

5. **Tuliptree.** Rabbits injured 90 percent of the trees one or more times during the first 5 years. The result was declining survival percentages of 92, 76, 45, and 26 for the first, second, third, and fifth growing seasons, respectively. Only a few scattered trees with multiple stems remain.

6. **Pitch pine** is a scraggy, limby tree not recommended for timber.

7. **Red pine** has had good survival, good form, and medium growth.

8. **Eastern cottonwood** survived well at first, but the soil is too dry for optimum growth and the trees are declining.

9. **Black walnut** trees in the moist draw are almost six times as tall as trees on the dry, westerly slope.

10. **Japanese larch** had poor initial survival. The few remaining trees exhibit excellent form and rapid growth. **Norway spruce** had poor survival and slow growth when young. Remaining trees have excellent form.

11. **Red oak** sustained greater rabbit damage than any other species. Growth is medium.

12. **Shortleaf pine** is about 200 miles north of its native range. It is not completely hardy and is not recommended.

13. **Eastern white pine** has shown good survival, growth, and form. It seems the best adapted of the pines in the plantation.

14. **Green ash** had less rabbit and mouse damage than any other hardwood.

15. **Sweetgum** was injured by frost during the first winter after planting. Trees in the draw are almost twice as tall as trees on the upland slopes. Form is good.

16. **American sycamore.** During the first two growing seasons 36 percent of the trees showed rabbit injury, but no mouse injury. Growth is slow and irregular.

17. **Loblolly pine** is the fastest growing species in the plantations. Planting stock was from a Maryland seed source. This southern species is not hardy in central Illinois but is recommended for southern Illinois.

18. **Virginia pine** was severely damaged by mice. It is limby, with poor form, and is not recommended as a timber tree in central Illinois.

Rabbits and mice have caused the greatest difficulties in these plantations. Dieback of established hardwoods from mouse injury was usually followed by sprouting, frequently resulting in multiple stems. Conifers that had been heavily girdled usually died.

Two articles by Jokela and Lorenz describe the damage caused by mice and rabbits: "Mouse Injury to Forest Planting in the Prairie Region of Illinois" (Jour. Forestry. 57:1) and "Damage Caused by Rabbits in the State 4-H Memorial Camp Plantation" (Ill. Agr. Exp. Sta. Forestry Note No. 50). Lorenz and Jokela have also made a detailed report on the loblolly pine plantation (Trans. Ill. St. Acad. Sci. 58:2).

Research on Respiratory Diseases of Livestock

With a new technique for growing viruses, veterinarians can control more of the respiratory diseases of cattle and swine

GEORGE T. WOODS

RESPIRATORY DISEASES account for a large proportion of the illnesses in livestock as well as man. The decreased feed efficiency and the deaths due to these diseases add up to serious losses for the livestock industry.

A major difficulty in studying and controlling respiratory ailments is their complexity. Many are caused by more than one organism, and some require expensive tests for accurate diagnosis.

One reason why pneumonia has remained such a serious problem in livestock is that a large number of bacteria and viruses may be involved. Only a few specific preventive vaccines are available against bacterial infections. So far the chief method of control has been to use good management practices and to treat animals with antibiotics and sulfonamide drugs after disease strikes. These drugs, however, are effective only against bacterial agents; they do not cure infections due to viruses.

In the past, we have been handicapped in preventing or curing virus-caused diseases because of the difficulty of cultivating viral agents for laboratory study. For many years chicken-egg embryos have been used to cultivate viruses, but not all viral agents will grow in egg embryos. Now, however, a technique has been developed for growing viral agents, in the absence of bacteria, in monolayer tissue culture cells.

Research on cattle diseases

The new tissue-culture technique is one reason why the College of Veterinary Medicine has been able to step up its research on viral agents in respiratory diseases of cattle. Another has been financial support from North Central regional research funds, the National Institutes of Health, and Abbott Laboratories.

To find the viral agents involved in acute respiratory diseases of cattle, we collected specimens from cattle affected in field outbreaks. As a result of laboratory examination, we isolated a number of viral agents.

Among these were two which had already been isolated and identified by other workers: bovine myxovirus-parainfluenza 3 (SF-4) and infectious bovine rhinotracheitis. The latter of these two viruses had been found in calves infected with shipping fever in California.

In addition, we isolated enteroviruses or closely related rhinoviruses, and members of the psittacosis-lymphogranularum (PLV) group. In some outbreaks, there was evidence of infection by more than one group of viruses.

Most work at Illinois has been on myxovirus-parainfluenza 3 virus. This virus has been isolated from humans, cattle, horses, and monkeys. Sheep, guinea pigs, and hamsters can also be infected. The human strain and the cattle strain are not identical, but are very closely related. Both have been used to infect calves in isolation rooms at the Veterinary Medical Research Building.

For the past five years, a commercial vaccine against SF-4 virus has been field-tested in calves at the Dixon Springs Agricultural Center, with the cooperation of M. E. Mansfield, G. F. Cmarik, and R. J. Webb. The vaccine has been helpful in preventing acute respiratory disease due to the SF-4 virus.

Swine diseases

Swine production, as well as cattle production, has been seriously affected by respiratory diseases. Among these ailments are swine influenza, virus pig pneumonia (VPP), atrophic rhinitis (AR), inclusion body rhinitis, enterovirus-induced pneumonia, and pleuropneumonia infections. Funds have been provided by the Illinois Department of Agriculture to intensify research on these diseases.

Swine research has been helped immensely by the development of specific-pathogen-free (SPF) swine. These are pigs which are deprived of their mothers' colostrum (first milk) and are raised in isolation to insure freedom from infection.

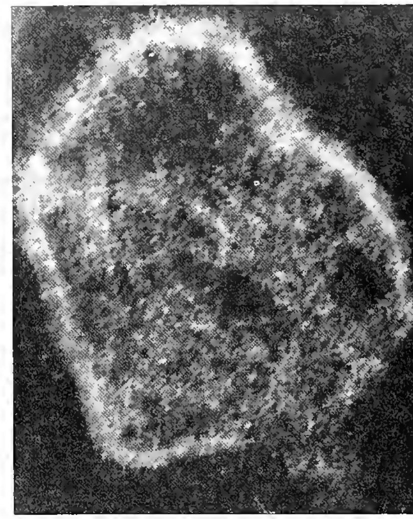
Right now we are placing emphasis on developing better diagnostic tests for virus pig pneumonia (VPP). This disease has been found in about 50 percent of all Illinois market-weight swine when observed at slaughter. It has been demonstrated that the disease can be eliminated from swine herds through repopulation with SPF swine.

Swine influenza is another prevalent disease in Illinois, but fortunately a good diagnostic test is available. Atrophic rhinitis is also common but apparently infects fewer herds than does VPP.

While research continues, practical steps are being taken to apply the information already available. The Illinois Swine Repopulation Association, cooperating with the National Association, is a group of swine producers organized to encourage herd health inspections and to provide healthy breeding stock for other swine producers. University research workers and extension veterinarians work closely with this association.

With the great increase in feeder pig production in Illinois, a full-time extension veterinarian has been

This calf had an acute case of shipping fever after being shipped into Illinois from Wyoming. The infectious bovine rhinotracheitis virus has been found in some calves with shipping fever.



Bovine myxovirus-parainfluenza 3 particle greatly magnified. (Courtesy Dr. A. P. Waterson, Cambridge, England.)

How chronic pneumonia affects pig lung and snout. Note dark lesions on the lung and absence of scrolls or turbinates on the snout.

This snout from SPF pig has normal scrolls or turbinates.

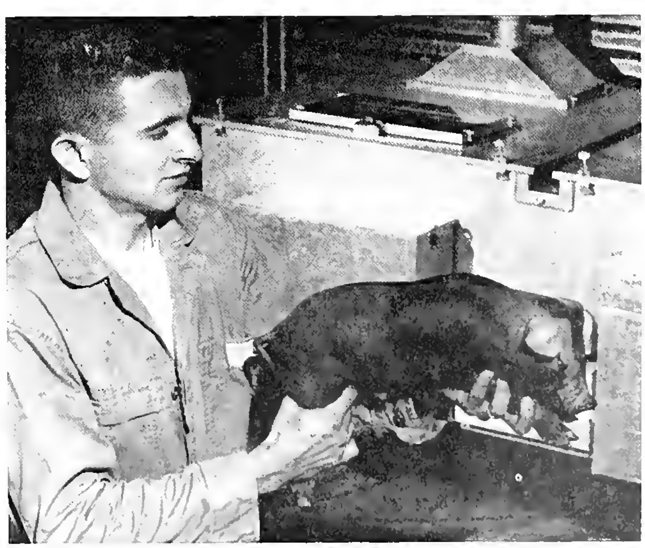
employed to provide liaison between the college, the swine producer, and the practicing veterinarian.

Significance of research

As research continues on respiratory diseases of livestock, major problems are being identified and information is provided for prevention and control.

Since many of the viral agents isolated from livestock are similar to those in man, the research is also applicable to problems of public health and comparative medicine.

George T. Woods is Associate Professor of Veterinary Microbiology, Public Health and Research.



A 4-week-old SPF pig is being removed from the brooder unit. It will complete its growth in an isolation room in the new Veterinary Medical Research Building.

Aerobic Treatment of Swine Waste

R. L. IRGENS and D. L. DAY

With intensified swine production systems, large volumes of manure are produced on small land areas. Disposal of this manure is a major problem as there may not be enough available cropland on which the manure can be spread without polluting surface and ground waterways.

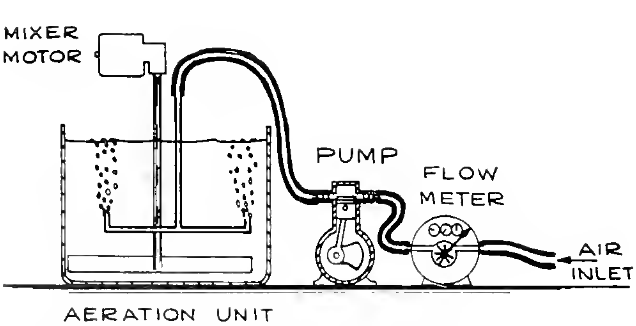
From laboratory studies thus far, it seems that the aerobic method of treating municipal waste can be adapted for swine waste. By this method, oxygen is added to the waste so that it can be stabilized by aerobic (oxygen-requiring) bacteria. When treated this way, municipal waste does not produce objectionable gases and odors, and the effluent will not pollute streams.

In undertaking the laboratory studies, the chief questions we had in mind were: How well can swine waste, which is more concentrated than municipal waste, be stabilized by aerobic treatment? How much must the liquid manure be diluted to obtain satisfactory results? How much air is required for the process of aerobic stabilization?

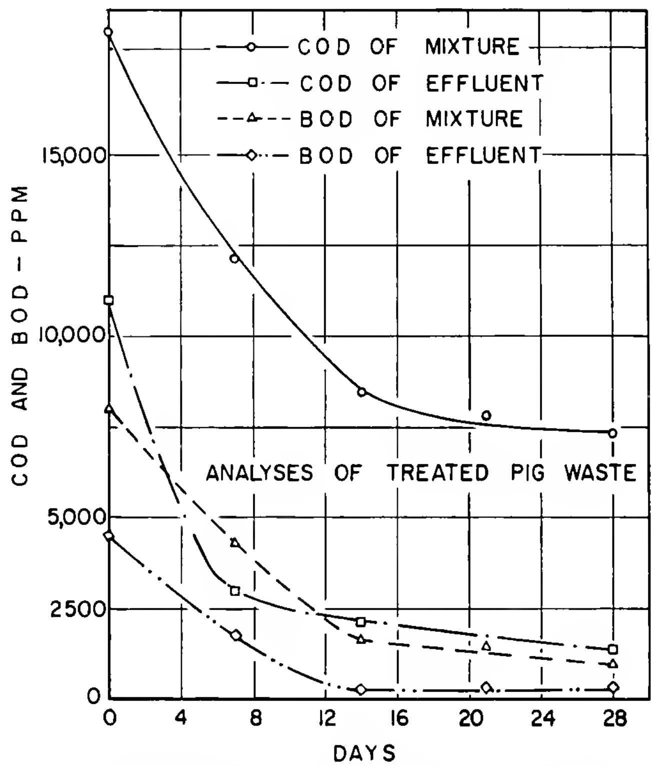
The waste used in these tests was collected from secondary SPF (specific-pathogen-free) swine in a totally slotted-floor finishing building on the Moorman Swine Breeding Research Farm. Waste from pits beneath the floors was pumped into a tank and mixed with a power mixer to obtain representative samples for laboratory analysis and stabilization.

The laboratory equipment used for investigating the effect of aeration on swine waste is shown below in Figure 1. Air was added to the waste through sparger stones, and the T-bar mixer circulated the waste and kept the solids suspended.

Some of the factors studied were: dilution required, air required, efficiency of oxygen usage by the aerobic bacteria, frequency and amount of loading, and characteristics of the surplus water and sludge. Before and after the waste was treated, we determined BOD (biochemical oxygen demand), COD (chemical oxygen demand), ammonia, nitrate, phosphate, organic nitrogen, volatile solids, and pH. Some typical results for a monthly loading schedule are presented in Figure 2.



Laboratory equipment used for the aerobic stabilization of swine waste. (Fig. 1)



Results of aerating pig waste accumulated in pit for 30 days. Before aeration, 4 liters of raw waste were diluted with 14 liters of treated waste from the previous experiment and 2 liters of activated sludge. Total dilution of pig excretement was 1:10. Air was supplied at 4 cubic feet per hour to maintain a dissolved oxygen content of 1 p.p.m. (Fig. 2)

Aerobic treatment of swine waste proved to be odor-free and did not attract flies. Carbon dioxide was the only gas produced, and most of it remained in solution as bicarbonate. The organic matter that was not oxidized to carbon dioxide and water was converted to stable solids. These were minerals which could easily be dewatered and dried on a sand bed, and may have significant soil-building and fertilizer value.

The effluent had a low BOD, 12 to 20 p.p.m., which will not pollute streams if discharged into them. Results of these experiments gave the following design requirements for an aerobic treatment plant: Volume in aeration tank or ditch — 6 cubic feet per pig; quantity of air required — 2,500 cubic feet per pound of BOD at 3 percent efficiency of oxygen utilization.

In the laboratory treatment system, results were more satisfactory when small amounts of manure were added

Experimental unit enclosed with plastic film is shown with door open. In picture is co-author D. L. Lebeda, Assistant in Agricultural Engineering.

Waste-Caused Air Pollutants Are Measured in Swine Buildings

D. L. LEBEDA and D. L. DAY

In the continuing effort to improve efficiency and quality in swine production, increasing attention is being given to the animals' environment.

Past research has been mostly on temperature control, heat exchange, and humidity. Now another aspect of the environment needs investigating. With the practice of collecting swine waste under partially or totally slotted floors, we need to find out what pollutants are produced and also determine the tolerance levels of swine to these pollutants.

Sludge from municipal-waste treatment plants under anaerobic conditions (that is, with no dissolved oxygen) can produce methane, carbon dioxide, hydrogen sulfide, and ammonia. Ponded swine wastes that have not been treated would be expected to produce the same gases since they are in the anaerobic state in collection pits and gutters.

All these gases can be toxic in excessive concentrations, although trace amounts may not be harmful. Hydrogen sulfide and carbon dioxide are heavier than air. Thus, if there weren't enough air circulation, they might accumulate in the lower parts of the buildings where the pigs breathe. Tolerance levels of swine for the gases are not yet known, but allowable threshold levels for humans (workers exposed 8 hours a day, 5 or 6 days a week) are given below.

Gas	*Threshold limit, p.p.m.*	*Physiologic action*
Ammonia (NH_3)	100	Irritant
Carbon dioxide (CO_2)	5,000	Asphyxiant
Hydrogen sulfide (H_2S)	20	Poison
Methane (CH_4)	1,000	Anesthetic
Sulfur dioxide (SO_2)	5	Irritant

A study was undertaken to determine concentrations of ammonia, hydrogen sulfide, carbon dioxide, and airborne bacteria, with and without forced ventilation, in swine buildings with fluid manure. Methane could not be measured with existing equipment; however, as indicated by the preceding figures, humans can tolerate concentrations of 1,000 p.p.m.

The experimental unit consisted of a pair of pens with totally slotted floors and a common manure pit. The unit was enclosed with plastic film, and a heating and ventilating system was installed in the enclosure. Heating cable was installed in the pit to allow pit temperatures of 60° to 82° F., the range considered important for anaerobic bacterial action.

Gas concentrations were determined by chemical absorption methods. Typical average results for two weeks of manure retention with 11 pigs and a ventilation rate of 35 c.f.m. per animal were:

Ammonia	7.4 p.p.m.
Carbon dioxide	656.0 p.p.m.
Hydrogen sulfide	0.09 p.p.m.
Sulfur dioxide	0.026 p.p.m.
Air-borne bacteria	4,800 per cu. ft.

The concentration of hydrogen sulfide was slightly higher when manure was retained for shorter times.

Without forced ventilation (some natural ventilation was possible since air inlet and exhaust ports were not blocked), average gas concentrations after 6 hours were:

Ammonia	18.8 p.p.m.
Carbon dioxide	4,286.0 p.p.m.
Hydrogen sulfide	0.28 p.p.m.

None of the gas concentrations were as great as the threshold levels for human occupancy, although carbon dioxide with no forced ventilation approached the threshold limit of 5,000 p.p.m. Research is planned to determine the tolerance levels of swine.

daily than when larger amounts were added weekly or monthly. It was thus concluded that odorless aerobic treatment could be integrated with self-cleaning slotted floors so the pig excreta would be deposited directly into the treatment plant. The manure-collection gutters could be connected at the ends to make a continuous channel and an aerator brush (paddle wheel) would keep the solids suspended, circulate the liquid manure, and add the necessary oxygen. Facilities to field-test this method are being constructed.

R. L. Irgens was formerly Research Associate and D. L. Day is Assistant Professor, Agricultural Engineering.

Hunters Are Having a Harder Time Bagging Deer in Sinnissippi Forest

HOWARD W. FOX

THE DEER in Sinnissippi Forest (Ogle County) are getting smart. Only 36 were taken during the 1964 three-day hunting season, and only 21 percent of the hunters were successful. During the first deer hunt in 1957, 82 deer were taken with 55 percent of the hunters being successful. In 1958, 50 percent of the hunters were successful, bagging 121 deer. Statistics for other years are given in Table 1.

The hunters' poor luck in 1964 indicates, for one thing, that the deer herds are being disbursed. We feel that we have nearly as many deer in the county as we ever had, but they are more scattered and are not bunched up in huge herds.

Probably the main reason for the decline in hunter success, however, is the increased canniness of the deer. Very few old bucks or does were taken in 1964. Most of the animals who had survived several hunting seasons were smart enough to avoid the hunter again. They headed for the dense pine plantations or corn fields, where it was next to impossible to find them.

Table 1. — Hunter Success at Sinnissippi

Year	Total kill	Bucks	Does	Hunter success
				pct.
1957	82	50	32	55
1958	121	57	64	50
1959	60	29	31	30
1960	41	17	24	22
1961	50	25	25	27
1962	43	27	16	21
1963	39	19	20	22
1964	36	16	20	21

Table 2. — Detailed Information for First Three Seasons

Information item	1957	1958	1959
Av. number of hours hunted	4.8	3.7	5.4
Av. number of deer seen	12	5.7	4.1
Av. number of shots taken	3.3	2.5	2.3
Pct. of bucks to does	61	47	49
Av. age, yr.	2.6	2.2	1.4
Oldest deer taken, yr.	7	7	4.5
Av. weight, lb.	130	122	98
Largest deer taken, lb.	263	229	200

Who hunts in Sinnissippi?

According to information obtained from the hunters in Sinnissippi Forest during the past two seasons, the average hunter was 44 years old and he traveled 204 miles to try his luck for one day at Sinnissippi. Many of the hunters, however, hunted elsewhere in Ogle County during the other two days of the season.

We found that 79 percent of our deer hunters had previously hunted deer, and that 55 percent had hunted in Sinnissippi Forest. Of these seasoned deer hunters, 78 percent had been successful in bagging a deer sometime in the past.

It was also interesting that 13 percent of the deer hunters had hunted for other species of large game elsewhere in the United States and in Canada. Nearly all the deer hunters (98 percent) had hunted small game in the past.

Every season about 10 percent of the hunters in Sinnissippi have itchy feet and will not stay on a stand. They just wander from place to place, increasing the danger to themselves and to other hunters. Such action tends to defeat the safety program that we feel is all-important. This type of hunter seldom gets his deer; he does, however, drive them by another hunter who is on a stand.

During the first three years we asked successful hunters for detailed information (Table 2) but we discontinued this practice after 1959. It is reasonable to assume that the experience gained in 1957 permitted

hunters to bag their deer (Table 2) in less time and with fewer shots in 1958. In 1959 fewer deer were seen during a longer period, but fewer shots were taken to bag the deer. This indicates that the hunters, as well as the deer, were getting smarter.

How the hunts are held

Requests for permits to hunt in Sinnissippi have been so numerous that since 1960 we have set up the hunt as a drawing. The drawing is held before July 1 so that if a person's name is not drawn he can apply in another county. Those whose names are drawn are allowed to hunt one day only.

Early on the day of the hunt, the hopefuls are grouped into five- or six-man parties. A guide who knows the forest well takes each group to an area of 150 to 250 acres and conducts the day's hunt according to the wishes of the group.

No hunting this year

Because of the small number of deer taken in 1964, Sinnissippi Forest will not hold a hunt in 1965 or 1966. This will give the herds a chance to build up again before we have another hunt.

Howard W. Fox, Assistant Professor of Forestry, is stationed at Sinnissippi Forest near Oregon, Illinois.

IMPROVING HORSERADISH THROUGH BREEDING

A. M. RHODES, J. W. COURTER, M. C. SHURTLEFF, and J. S. VANDEMARK

HORSERADISH, grown for its pungent roots, is one of our oldest condiments and still a popular one. About 60 percent of the horseradish in the United States is produced in the Mississippi River valley near East St. Louis, making this area the unofficial horseradish capital of the world.

Three general types of horseradish are grown in Illinois — Common, Bohemian, and Swiss. Common, which is the principal commercial type in Illinois, and Swiss, which has gained much popularity in recent years, generally produce the best quality roots for processing. Bohemian, however, is more resistant to turnip virus 1 and white rust diseases, which can cause serious losses. Common has broad, crinkled leaves; Bohemian has narrow, smooth leaves; and Swiss is intermediate in leaf type.

Until the twentieth century, the only way of improving horseradish was to select roots of desirable plants (clones). Although horseradish plants flower profusely, they are usually self-sterile and seldom produce viable seed. Luther Burbank once offered $1,000 for an ounce of horseradish seed. Although he received many packages, none of the seed produced horseradish plants.

The first record of viable seed from horseradish is that of Brzezenski, a famous Polish horticulturist, who grew seedlings in 1907. Since then, viable seeds have been produced at the University of Wisconsin in 1948 and more recently in Czechoslovakia, Denmark, and at the University of Illinois.

In Illinois the problem of producing viable seed has been overcome by using Common as the female parent and Bohemian or Swiss as the male parent. Crosses were made in an effort to combine such desirable characteristics as improved disease resistance, better root quality, and increased yields. Over 500 seedlings are now being tested.

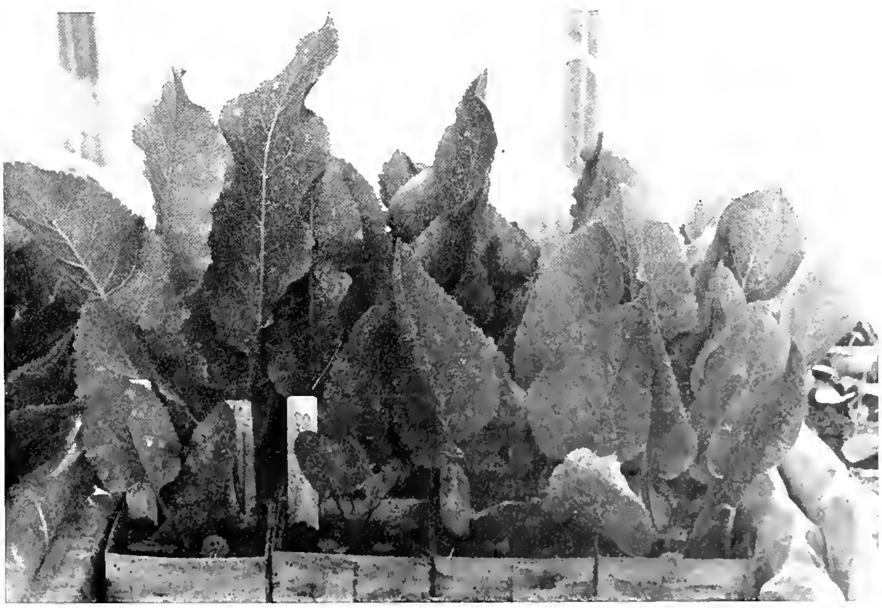
In addition, horseradish stocks have been collected from many states, Canada, Japan, Russia, and England. More than 50 cultivars are being evaluated along with the seedlings. It is hoped that improved horseradish varieties will soon become available to Illinois growers.

Grants from the commercial growers of Madison and St. Clair counties and the National Association of Horseradish Packers support this program.

A. M. Rhodes is Associate Professor of Plant Genetics, Horticulture Department; J. W. Courter is Assistant Professor of Horticulture; M. C. Shurtleff is Professor of Plant Pathology Extension; and J. S. Vandemark is Professor of Horticulture.

Horseradish naturally flowers in April and May in Illinois. Mature roots can be forced in the greenhouse if previously given two months' cold treatment at 35° F. Inflated seed capsules are easily recognized.

Mature seed capsules may each contain two to six seeds. More often they don't have any seeds at all.



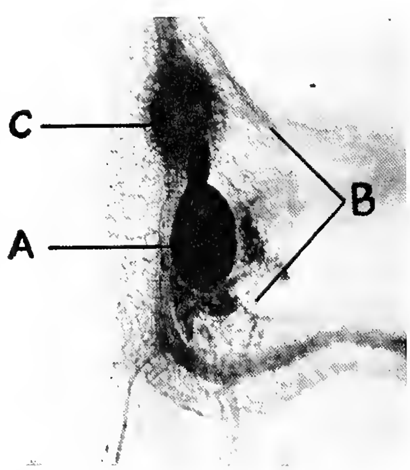
Vigorous horseradish seedlings growing in 3-inch plant bands. Seedlings usually remain in the greenhouse for a year before they are planted in the field.

RESEARCH IN BRIEF

Root-Knot Nematode Attacks Bentgrass on Putting Greens

Bentgrass collected at two Du Page County golf courses in 1963 was found to be infected with an unidentified root-knot nematode (*Meloidogyne* sp.). Initial tests proved that this nematode could reproduce on several strains of bentgrass, and samples taken in 1964 demonstrated that the parasite could overwinter in northern Illinois. This is the first record, anywhere in the world, of a root-knot nematode attacking bentgrass.

No differences in top growth were detected between infected and healthy plants on the golf courses or in the greenhouse. Many abnormalities, however, were found in infected roots. The most striking of these were: swollen root tips, produced in response to invasion by nematode larvae; spindle-shaped swellings on older roots; root galls or "knots"; and "root rings." The latter are loops produced by a root tip growing in a 360° arc before resuming the original direction of growth. When any of these malformations were stained, one or more nematodes, in various stages of development, were seen. Often infected roots produced more lateral roots than did healthy roots.



Stained infected bentgrass root. A — maturing root-knot nematode; B — galled portion of root; C — affected conductive tissue.

When infected roots were cut into thin sections and stained, the following disturbances were seen: a large portion of the swollen root tissue was composed of the nematode body; an increase in the number of cortical cells was found; xylem (conductive) cells had increased in both size and number; and some of the xylem cells had been transformed into "giant cells" upon which root-knot nematodes are known to feed.

In all roots observed, however, at least part of the conductive tissue was intact and continuous around each infection site. It seems probable that water and minerals, normally transported through the xylen, can bypass nematode infections in the conductive tissue. Thus, enough water and minerals reach the tops of infected plants to produce good growth with the high rates of fertilization and irrigation used on golf courses.

The spread and development of this disease in Illinois will be studied in the future. Particular attention will be given to any changes in the nematode that will make it a more damaging pest. — *Donald P. Taylor and Clinton F. Hodges*

Food-Purchasing Practices of Married Students Living in University Housing

With the wide choice of foods on the market and the modern homemaker's limited time for food planning, buying, and preparation, we need to know more about the way food-purchasing decisions are made. Such information would be helpful in planning consumer-education programs as well as in food production and marketing.

Purchasing practices have been included in some studies of food utilization, but little research has concentrated exclusively on food-purchasing practices of young families. Such a study seemed pertinent, not only because young families make up a large segment of the population, but also because it would offer an opportunity to determine if the presence of pre-school children in a family affects food purchases.

A survey of married students living in University housing was made in 1964 to investigate food-buying practices, some specific purchases, effects of the presence of pre-school children upon food-buying decisions, and the children's food intake.

The group, chosen at random, consisted of 123 families, including 79 with at least one child two to four years old and 44 without children. Two-thirds of the husbands were Ph.D. candidates and three-fourths of the wives had attended college. In families with children 28 percent of the wives were employed outside the home; in childless families, 84 percent. Most of the incomes were below the 1963 national average of $6,200; 70 percent were below $4,700.

Almost all families planned their food purchases carefully and were quite price-conscious. They did their major shopping once a week, and in an effort to save money over 80 percent shopped at more than one store during a month. Fifty-seven of the 123 families said they selected a store on a price basis. Other reasons mentioned, in order of importance, were selection of products, convenient location, quality of meat, service, and trading stamps. Extensive use of a written shopping list was further evidence of planning. A list was used by 86 percent of the families with children and 64 percent of those without children.

Purchases of milk and other dairy foods, cereals, fruit juices, and powdered beverage mixes were investigated because of their importance in the diets of pre-school children.

The families bought more milk, ice cream, and cheese per person than the national average. Childless families bought more frozen orange juice per person in a week than did families with children. The latter group bought more canned juices, drinks, and powdered beverage mixes. Pre-sweetened cereals made up about half of the cereal bought by families with children, but were used very little by childless families.

Each of the 79 mothers was asked what one pre-school child in the family had eaten the day before the interview. Food consumption has not yet been analyzed for specific nutrients. However, average number of servings consumed per child were compared with recommended servings from the basic food groups (dairy products, meat and eggs, bread and cereals, fruits and vegetables), and diets seemed adequate.

Information obtained from this pilot study of young University families should not be extended to the general population. More studies are needed to determine whether other young families use comparable buying practices. — *Glenna H. Lamkin, Barbara Price, and Mary Lou Hielscher.*

Dr. Bentley Succeeds Dr. Howard as Dean of College of Agriculture

DR. ORVILLE G. BENTLEY took over his dnties as Dean of the College of Agriculture on September 20. He came to Illinois from South Dakota State University, where he had been Dean of the College of Agriculture since 1958

Previously he had been on the staff of Ohio State University in the Departments of Animal Science and Agricultural Biochemistry. From 1942 to 1946 he served in the Chemical Warfare Service, holding the rank of major when he was discharged.

Dr. Bentley received his education at South Dakota State College and the University of Wisconsin. He is a member of a number of professional and honorary organizations and is the author or co-author of about 40 scientific publications. Most of his research has been aimed at increasing the efficiency with which cattle and sheep use forage.

Dr. Bentley succeeded Dr. Louis B. Howard, who had been Dean of the College since 1954. Dr. Howard came to Illinois in 1948 as head of the newly organized Department of Food Technology, and became Associate Director of the Agricultural Experiment Station in 1951. Before joining the University staff, he was with the U.S. Department of Agriculture.

Dr. Howard is widely known for his research and publications on a variety of subjects related to food processing and the utilization of agricultural commodities for industrial purposes. Among his many honors is a certificate of appreciation from the U.S. Army for his leadership in expanding food-processing facilities during World War II.

It was to continue his research and other professional activities that Dr. Howard asked to be relieved of his duties as dean. He is remaining on the staff as Professor of Food Science and is now on sabbatical leave.

Land Trusts Are a Possible Way of Transferring Farms Without Affecting Operation

Although the land trust is not widely used in Illinois, its advantages in estate planning make it an attractive legal device for some landowners. A land trust can serve to consolidate title, make individual interests transferable without disturbing the farm unit or its operation, and at the same time reserve the management to the owners, who are beneficiaries under the trust.

This last point distinguishes the land trust from an ordinary trust. With an ordinary trust, the trustee exercises part or all of the management. With a land trust, the real estate is conveyed to a trustee, reserving to the beneficiaries the full management and control of the property. The trust property is real estate, but the interest of the beneficiaries is personal property. The trustee executes deeds and mortgages or otherwise deals with the property at the written direction of the beneficiaries. The beneficiaries improve and operate the property, collect rents, and exercise all rights of ownership except holding or dealing with the legal title.

The arrangement is created by two instruments. The deed in trust conveys realty to the trustee and at the same time a trust agreement is executed between the owner or owners and the trustee. The trustee agrees to deal with the property only upon the written direction of the beneficiaries or the persons named as having power of direction. He is not required to inquire into the propriety of any direction received from authorized persons. He has no duties regarding management or control of the property or payment of taxes or insurance.

The death of a beneficiary does not terminate the trust or necessarily affect farm operation. Unless otherwise provided in the trust agreement, the interest, being personalty, passes not to his heirs but to his personal representative.

No tax problems were revealed in a sample survey of land trusts involving farm land in Illinois. There are some potential tax problems, however, if the trust agreement is not carefully drafted or if the operation is not carried out in accordance with the agreement. *N. G. P. Krausz*

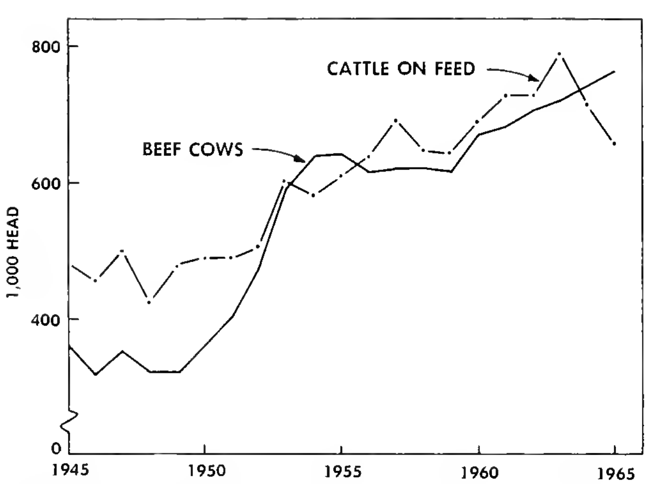
FARM BUSINESS TRENDS

CATTLE have always been a prominent part of Illinois agriculture. Before the land was plowed and fenced, large herds were grazed on the tall prairie grasses.

Cattle supplied many important things needed by pioneer families. They produced beef, veal, milk, butter and cheese for food; leather for shoes, clothing, harness, containers, hinges, and many other uses; tallow for candles and axle grease; power for drawing carts, wagons, plows and other farm implements; and money for buying essential manufactured goods from the East.

Some of the early cattlemen were big operators, even by today's standards. For example, Benjamin F. Harris, a pioneer in Champaign County, owned some 10,000 acres of land and drove his cattle to market in Philadelphia.

The statistical record of the Illinois cattle industry begins in 1867. At that time, nearly 100 years ago, Illinois farmers had 1,700,000 head of cattle and calves. Average value was $20.60 a head, and total value, $35 million. Illinois farmers now have about 4,000,000 cattle valued at $465 million.



Number of cattle on feed and beef cows on farms in Illinois, January 1, 1945-1965.

In 1867, 590,000 of the cattle, 35 percent of the total, were milk cows. The number of milk cows trended slowly upward until 1935, when it reached a peak of 1,231,000. Since that time it has decreased almost every year. On January 1, 1965, the number of cows kept for milk was estimated at 517,000, or 42 percent of the high point 30 years ago.

The earliest estimate of the number of cows not kept for milk was in 1920, when 272,000 were listed. Beef cow numbers decreased sharply during the 1920s, shrinking to only 107,000 in 1930. Since 1930, however, the number of beef cows on Illinois farms has increased seven-fold. On January 1 of this year Illinois farmers had 766,000 beef cows, according to official estimates.

The U.S. Department of Agriculture began making reports of cattle on feed in 1925. The earliest reports suggest that Illinois farmers generally had around 400,000 cattle in their feedlots on January 1. Most of them were heavy steers, two and three years old.

The number of cattle fed apparently trended downward during the late 1920s and early 1930s. Extreme drouth cut feed production after 1932. Consequently the number of cattle on feed January 1 reached its all-time low of 279,000 in 1935.

Since then, cattle feeding has trended upward. The number on feed January 1, 1963, was estimated at 787,000, about double the number usually fed a generation ago.

The number of cattle on feed January 1 decreased in 1964 and again at the beginning of 1965. This decrease may prove to be a leveling off rather than the beginning of a general decline of cattle feeding in Illinois. At mid-1965 Illinois farmers were feeding 6 percent more cattle than one year before.

Sales of cattle and calves bring Illinois farmers around $500 million a year, more than one-fifth of all cash receipts from farm marketings. No other farm product consistently produces greater cash receipts for Illinois farmers. — *L. H. Simerl*

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Programed instruction is a new venture of the Cooperative Extension Service. Using slides, audio tape, and an instruction manual, students can move at their own pace (page 16).

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CONTENTS

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NEWS AND VIEWS

Reasons for involvement in international research programs

How, where, and when should American universities and individual staff members become involved in international research programs? An important criterion is what the American and overseas institutions, and their staffs, have to gain over the long pull. This criterion is examined from three standpoints: (1) exchange of information, (2) cost advantage, and (3) "cultural considerations."

Exchange of information. Scholars of the world have long exchanged scientific information, and this practice requires no further elaboration. We take knowledge where we find it.

Cost advantages. Although national boundaries are sometimes crossed to conduct research in the least-cost location, this is not routine. The case for locating each phase of a research program in the least-cost area is similar to that for international trade in commodities. The logic of the case is clear.

"Cultural considerations" are worth special attention. To what extent is a man "culture bound" when he poses the questions and hypotheses around which he develops his research? If the questions are "culture bound," then how much are the answers also bound to a particular culture and environment? Specifically, are the laws of economics, sociology, political science, biology, and physical science, as we know them, generally true? Or are they unique to specific cultures or geographical areas?

There is some evidence that men in all disciplines are "culture bound" when asking questions and formulating hypotheses. Since principles derived from research reflect in part the questions we ask, it follows that the "general principles" we know may not be independent of cultural and environmental factors.

Each individual should ask himself if there is any point in trying to get out of his cultural binds. When the answer is yes, how does he do it? How, for example, does a person get the insight to ask the right questions and formulate significant hypotheses? Perhaps one small aid is to work within a greater variety of cultural and environmental situations, through the vehicle of international research projects. — *George K. Brinegar, Assistant Director, Agricultural Experiment Station*

Blood Plasma Shows Whether Diet Has Enough Amino Acids

Techniques developed to determine amino acid requirements of chicks have wide application in the study of human and animal nutrition

W. F. DEAN, R. A. ZIMMERMAN, and H. M. SCOTT

Professor Scott collects a sample of chick's blood for analysis.

NEW TECHNIQUES developed in the Department of Animal Science are opening up new areas of knowledge about amino acids, the protein constituents that are essential for the body's growth and metabolism.

The techniques evolved from studies of the amino acid requirements of young chicks. One technique is the use of a reference diet made up entirely of chemicals, corn starch, and corn oil taken from the laboratory shelf (Table 1). The diet includes 15 crystalline amino acids (Table 2), as well as 16 vitamins and 13 minerals.

Table 1. — Composition of Reference Diet

Ingredient	Pct. of diet
Corn starch	55.95
Amino acid mixture	19.48
Corn oil	15.00
Salt mixture	5.37
Cellulose	3.00
$NaHCO_3$	1.00
Choline chloride	0.20
Vitamins	+
Total	100.00

Table 2.—Composition of Crystalline Amino Acid Reference Standard

Amino acid	Pct. of diet	
L-arginine HCl	1.21	(1.00)*
L-histidine $HCl.H_2O$	0.41	(0.30)*
L-lysine HCl	1.19	(0.95)*
L-tyrosine	0.45	
L-tryptophan	0.15	
L-phenylalanine	0.50	
DL-methionine	0.35	
L-cystine	0.35	
L-threonine	0.65	
L-leucine	1.20	
L-isoleucine	0.80	
L-valine	0.82	
glycine	1.20	
L-proline	0.20	
L-glutamic acid	10.00	
Total	19.48	

* Free base.

Development of the diet

Years of experimentation went into the development of the diet. Ingredients were mixed in many different proportions until a diet was developed that supported a reasonably satisfactory rate of growth. The diet was then further tested to find the optimum amounts of the different amino acids. This was done by varying the level of one amino acid while holding the others constant.

Table 3 shows the results when histidine was the experimental variable. Chicks on the lowest concentration of dietary histidine (0.10 percent) grew very slowly. Both weight gain and efficiency of feed utilization improved with each increment of histidine until a concentration of 0.30 percent was reached. Responses leveled off with increments beyond this minimum requirement. Comparable assays were conducted to determine concentrations of the other 14 amino acids shown in Table 2.

Table 3. — Results of Varying Histidine Level in Chicks' Diet

Histidine, pct. of diet	Daily gain per chick, gm.	Gain per gm. of feed, gm.
0.10	1.67	0.22
0.15	4.33	0.43
0.20	6.72	0.53
0.25	11.50	0.69
0.30*	15.62	0.78
0.35	15.22	0.77
0.40	15.33	0.80
0.45	15.28	0.77
0.50	15.62	0.78
0.55	15.72	0.81

* Accepted as requirement level.

In every assay the chicks have been very sensitive to alterations in the pattern of the amino acid mixture. The sensitivity has been reflected not only in growth (Table 3), but also in nitrogen retention and composition of the carcass.

Before the chemical reference diet was developed, highly purified intact proteins, such as casein or isolated soybean protein, were used to study the role of amino acids in the diet. Since each intact protein consists of many amino acids in varying proportions, as well as other compounds, it was difficult to control the intake of specific amino acids without altering the levels of other dietary constituents. Because of these variations, experimental data could not be interpreted as confidently as data obtained from the chemical diet.

Plasma measurements

Once the reference diet was developed, a question arose as to the best method of measuring the effects

W. F. Dean and R. A. Zimmerman were formerly Assistants in Animal Science; H. M. Scott is Professor of Animal Science.

of dietary variations. Measuring the growth rate is time-consuming and leaves something to be desired in the way of precision. Investigations were therefore undertaken to determine whether concentrations of free amino acids in blood plasma would reflect variations in dietary amino acids. Assays were designed so that we could compare the plasma amino acid levels of chicks fed the complete reference diet and of chicks fed the same diet altered to create the desired dietary regimen.

Each chick was fed 0.8 gram of its diet at half-hour intervals until it had received 12 feedings. This method of feeding insured that the chicks would readily consume all of the feed given them. Thus, over a 6-hour period, the intake of all nutrients would be equal except for the amino acid (or acids) being tested. Half an hour after the last feeding, a sample of blood was drawn by heart puncture and was prepared for analysis by ion exchange chromatography.

Assays have been conducted in which the reference mixture of amino acids (Table 2) has been modified to create (1) single amino acid deficiencies, (2) multiple amino acid deficiencies, (3) excesses of single amino acids, and (4) multiple amino acid deficiencies and excesses combined.

In a typical assay, chicks were fed a diet that contained just half as much lysine as they needed. Chicks on this lysine-deficient diet had already been found to gain only a third as fast as chicks on the standard reference diet. As shown in Table 4, plasma lysine was depressed in chicks fed the deficient diet, while plasma levels of all other amino acids were increased, the essential ones more than the nonessential ones.

In general, the results obtained to date support the view that amino acid deficiencies in the diet are reflected in lower plasma values for these amino acids; and that excess amino acids are reflected in increased plasma values.

This observation paved the way for subsequent experiments which showed that the plasma technique

Table 4. — Effect of Dietary Lysine Deficiency on Concentration of Free Amino Acids in Blood Plasma

Amino acid	Standard reference diet (A)	Lysine-deficient diet (B)	Pct. change*
	mcg./ml. plasma		
Lysine	35	20	− 43
Valine	38	71	+ 88
Threonine	120	264	+120
Isoleucine	9	29	+222
Tyrosine	10	24	+140
Phenylalanine	10	18	+ 80
Cystine	19	46	+142
Methionine	9	23	+156
Leucine	15	39	+160
Arginine	16	69	+331
Histidine	15	36	+140
Glycine	77	109	+ 42
Serine	41	74	+ 80
Glutamic acid	78	111	+ 42
Glutamine+asp.	71	123	+ 73
Alanine	196	255	+ 30

* Calculated as $\frac{B - A}{A} \times 100$.

can be used to determine a chick's amino acid requirements. Dietary levels of three amino acids (lysine, arginine, and valine) were varied, one at a time. Plasma concentrations of the amino acid being tested were measured and were compared with the chicks' growth on the experimental diets.

Results when lysine was the variable are shown in the graph. Although lysine deficiency in the diet was reflected by low plasma concentrations, the concentrations did not vary appreciably with degree of deficiency. Plasma values took an upward turn when the diet contained 0.9 percent lysine, and it was at this point that the chicks reached their maximum rate of gain. With further increases of lysine in the diet, plasma values shot upward. At the same time, rate of gain leveled off, dropping when the dietary lysine level reached 1.8 percent. This drop was to be expected, because it is well known that excess lysine will depress appetite, which in turn depresses feed intake and rate of gain.

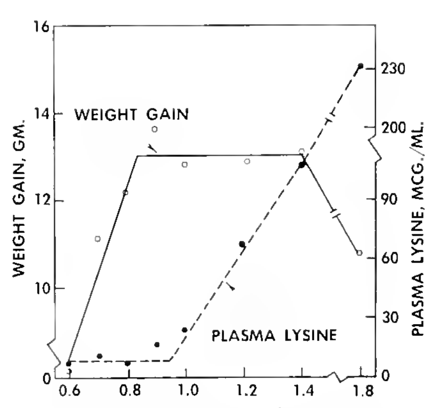
Similar patterns were found for the other two amino acids studied; that is, plasma values started to rise at precisely the same time that the chicks began making maximum gains. With this knowledge, the chick's requirements for specific amino acids at different stages of development can be measured more rapidly and precisely than in the past.

In other experiments, the plasma technique has been used to good advantage in identifying amino acid deficiencies in such proteins as soybean oil meal, fishmeal, casein, and egg. At present, the possibility of using blood titres to determine the availability of the amino acids in natural feedstuffs is being explored.

Wide application

The plasma technique of determining amino acid deficiency is not confined to the study of chick nutrition. Scientists all over the country are interested in the possibility of using the plasma technique to study the amino acid nutrition of other animals, including man. Here at Illinois, for example, the technique has been used in studies of swine.

A far-reaching application of the observations noted in the chick could be in the study of kwashiorkor, a protein deficiency syndrome in human infants. This form of malnutrition appears with similar clinical symptoms in many underdeveloped areas of the world on contrasting dietary regimens. A better understanding of how free amino acids accumulate in blood plasma is needed if human plasma titres are to be reconciled with dietary intakes of the amino acids in underdeveloped areas.



Weight gain and plasma lysine concentration with different levels of dietary lysine.

Light-colored Piasa soils (natric) are mixed with darker Cowden soils (non-natric) on this nearly level plowed field.
(Fig. 1)

NATRIC SOILS IN ILLINOIS

Gypsum shows promise for increasing productivity of "slick spots" or "scalds" in the south-central and western parts of the state

J. B. FEHRENBACHER, R. T. ODELL, P. E. JOHNSON, and B. A. JONES, JR.

"SLICK SPOTS" or "scalds" occupy some 381,000 acres in south-central and western Illinois, posing a problem on many farms.

These spots are light-colored and are irregular in size and shape. Technically they are known as natric soils. Their subsoils contain a natric horizon, which is defined as having considerable clay accumulation, prismatic or columnar structure, and more than 15 percent saturation with exchangeable sodium.

Natric soils dry out more slowly in the spring than associated soils. Once they are dry, their moisture storage is not easily replenished, because of their very slow permeability. The high exchangeable sodium content in the subsoil causes the clay to be dispersed, creating an unfavorable environment for root growth. For all these reasons, crop yields are often lower than on surrounding soils.

Common natric soils

Huey and Piasa silt loams are the most extensive natric soils in Illinois. Huey is often associated with Cisne soils; Piasa, with Cowden and Herrick soils. Huey is lighter colored than Piasa. Both are nearly level and poorly drained.

Tamalco silt loam and Walshville loam are moderately well drained natric soils found on sloping areas. Tamalco commonly occurs in association with Hoyleton and Oconee soils.

Huey, Piasa, and Tamalco developed from loess that is usually less than 8 feet thick on weathered glacial till. Walshville developed from glacial till of Illinoian age.

Figure 2 shows these soils' occurrence in relation to major grassland soil associations in south-central Illinois. The regional distribution of natric soils is influenced by the intensity of weathering in the parent loess or till and by the amount of underlying glacial till that is included in the lower part of the soil. (Glacial till has less total sodium than loess does.) Natric soils are most common in Bond, Clinton, and Washington counties, where maximum weathering occurred in surficial soils that developed entirely in loess.

The sequence of horizons is about the same in the natric soils as in their associated soils. Natric soils, however, have lighter colored surface horizons and thinner subsurface (A_2) horizons. Also, the prismatic and columnar structure of the subsoil is more weakly developed in the natric soils, and permeability is slower. Exchangeable sodium content of the subsoils is 3 to 7 me. per 100 grams of soil for the natric soils (Fig. 3), but less than 1 me. for the associated soils. (A sodium content of 1 me. per 100 grams of soil equals 460 pounds of sodium in the top 6 inches of an acre.) Natric soils have alkaline subsoils which contain a random distribution of carbonate concretions. Associated soils have acid subsoils.

The high exchangeable sodium content of the natric soils is usually concentrated in the subsoils. Sodium content is low in the underlying till and bedrock and is also usually low

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J. B. Fehrenbacher is Associate Professor of Pedology; R. T. Odell, Professor of Pedology; P. E. Johnson, Assistant Professor of Soil Fertility; and B. A. Jones, Jr., Professor of Agricultural Engineering.

in the surface soil. Surface soils are also acid and low in nitrogen, available phosphorus, and available potassium.

Genesis of natric soils

The exchangeable sodium in natric soils came from the weathering of sodium-bearing minerals, chiefly feldspars, in the loess and till from which natric and associated soils developed. Water moving through the soils removed sodium from some areas and deposited it in others.

Lateral seepage of ground water accounts for concentrations of sodium near the base of slopes. In nearly level areas, where lateral seepage is negligible, concentrations of sodium are explained by the permeability of the old soil that had developed in the glacial till before loess was deposited. Till underlying natric soils is four or five times more permeable than that underlying associated soils. In the early stages of soil development, downward percolating water or the moisture streamlines were channeled through this permeable till; consequently the soluble products of weathering were concentrated in the lower part of the loess (Fig. 4, initial stage). Because of the low carbon dioxide pressures at this depth and the drying of soils in late summer, calcium and magnesium were precipitated to form carbonate concretions, and the proportion of sodium increased.

With increasing sodium concentrations in the soil water, the B horizon became more and more saturated with sodium, more dispersed, and less permeable. Now the B horizon is only about one-seventeenth as permeable in natric soils as in associated soils.

Once this very slow permeability developed, the natric soils did not wet up very fast or very often. With the resulting moisture gradient, water moving downward from the surface or laterally from wetter associated soils was intercepted, and sodium was concentrated on the clay. Repeated cycles of wetting and drying caused the dispersed B horizon to migrate both upward and laterally, so that this horizon is shallower in natric soils than in associated soils. When the B horizon of natric soils became less permeable than that of associated soils, downward moving water was mostly channeled through non-natric soils (Fig. 4, advanced stage).

As long as drainage water can pass through the non-natric soils to underground outlets, the sodium released by weathering will be moved out of the soil and the high-sodium condition will not develop or spread.

Gypsum may solve problem

Crop yields on natric soils can be improved somewhat by proper, conventional soil treatment, but this does not solve the basic problem. If these soils are to be improved, the high exchangeable sodium content of their subsoils must be reduced and the excess sodium removed by drainage.

Characteristics of these soils suggested that calcium can replace sodium at the cation exchange sites of the clay. Gypsum (calcium sulfate) appeared to be a promising material for supplying the calcium. Samples of high-sodium subsoils were accordingly treated with gypsum in the laboratory. Results were encouraging. The gypsum replaced the exchangeable sodium and kept the soil aggregated so sodium could be leached out, especially when the gypsum and soil were mixed.

Field tests were started on Huey silt loam at the Newton Agronomy Field in August, 1963. Because of poor natural underdrainage, all plots except two check plots were tiled at a depth of 3 feet. Drainage water from each plot flows through solid plastic pipes to one of the two instrument houses, where volume is automatically measured and the water is sampled for analysis.

An intensive study was undertaken to see how completely the exchangeable sodium could be removed and the soil renovated, and also to check the effectiveness of different tile spacings. The study is being conducted on 12 plots, each 12 feet long. Widths are 10, 30, and 60 feet. Spacings of the tile lines are the same as the plot widths, as a line is in the center of each plot, running the 12-foot length.

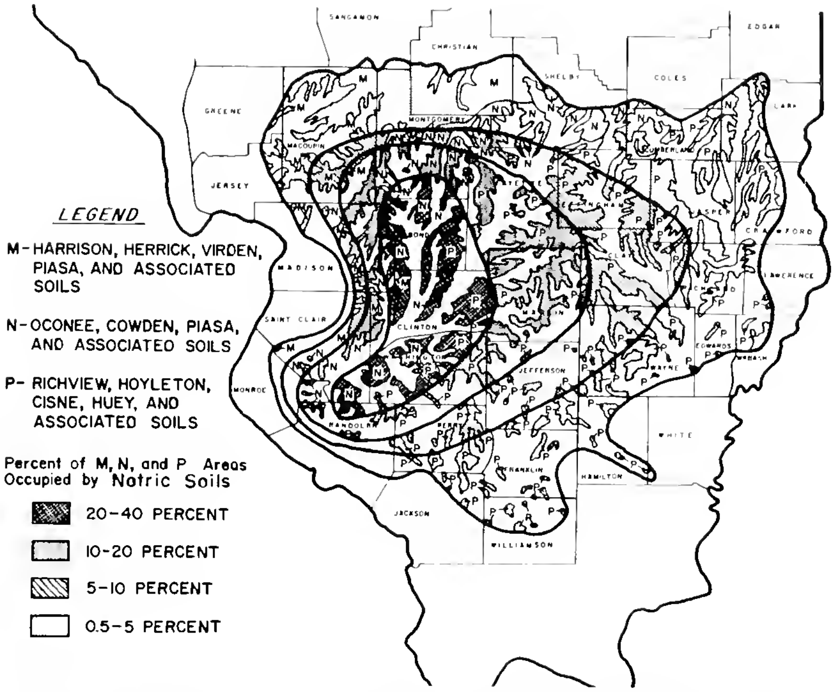
The top 3 feet of soil on each plot was dug with a backhoe. Gypsum, at the rate of 27.8 tons per acre, was thoroughly mixed with the soil on six plots (two of each width). Mixing the gypsum to a depth of 3 feet insured that it would be in the zone with the most exchangeable sodium. The 27.8-ton rate represented the amount necessary to replace the exchangeable sodium in the upper 3 feet of the Huey soil in the plots. Phosphate and potash treatments, based on the results of soil tests, were added to all plots to correct deficiencies to a depth of 3 feet.

Since the above treatments are very intense, more practical experiments were also started. These tests are all on plots 30 feet wide and 12 feet long. Phosphate and potash were applied to correct deficiencies to a depth of 2 feet. Gypsum was added at the rate of 10.7 tons per acre, which is the amount needed to replace the exchangeable sodium in the upper 2 feet of soil.

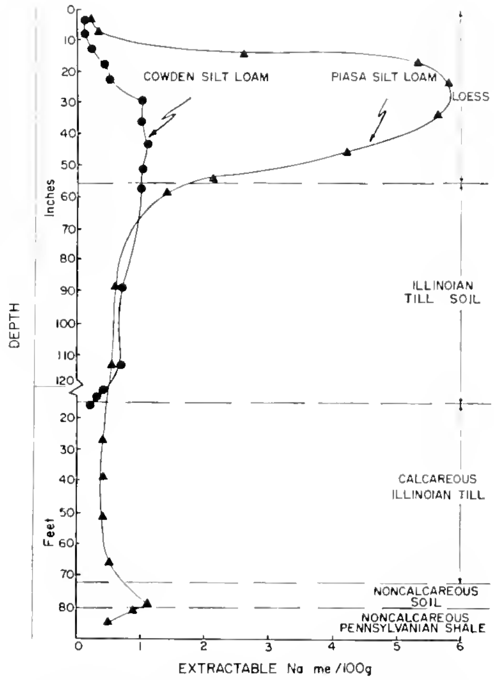
These are the treatments, each made in duplicate: gypsum applied in the surface or plow layer and tiled; gypsum applied in the surface without tiling; tiling but no gypsum; and gypsum chiseled in to a depth of 2 feet and tiled (Fig. 6). Chiseling was 2 feet apart both north and south and east and west.

Each year 160 pounds of nitrogen per acre are added to all plots in the entire experimental setup. The plots have all been lined with plastic sheets to a depth of 3 feet. This was done with a trenching machine after the plots were laid out. The sheets prevent lateral water movement into or out of the plots.

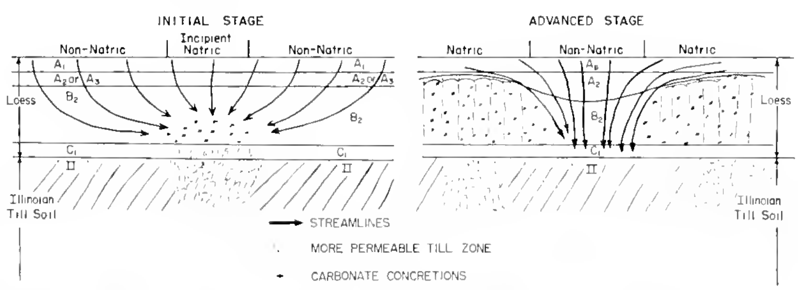
Corn was grown in 1964 and 1965, with yields for the different treatments varying considerably in both years. Some of the results appear promising, but more data are needed before anything conclusive can be said concerning the effect of gypsum on natric soils.



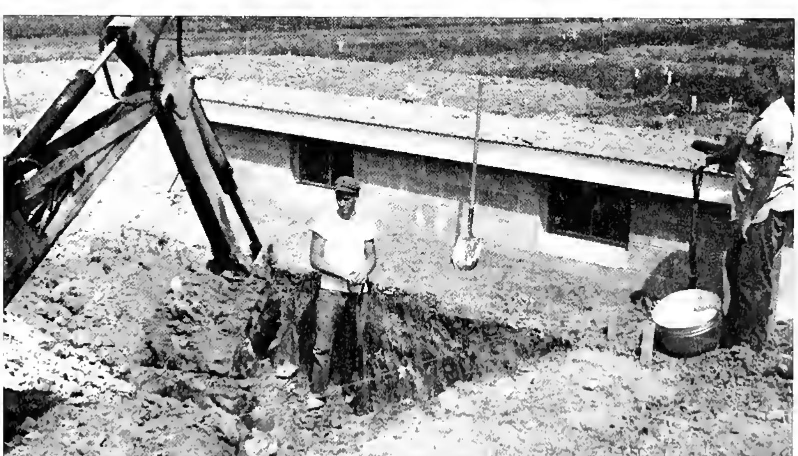
Frequency of occurrence of natric soils in relation to major grassland soil associations in south-central Illinois. In addition, natric soils occur on 0.5 to 5 percent of "M" areas in Hancock, McDonough, Schuyler, Adams, and Brown counties in the western part of the state. (Fig. 2)



Distribution of exchangeable sodium in Cowden and Piasa profiles. The sodium content of Piasa is high in the subsoil but low in the underlying till. (Fig. 3)



How moisture moves through soil during the initial and advanced stages of natric soil development. (Fig. 4)



Digging the soil in one of the plots at the Newton Agronomy Field. On this plot gypsum was added by hand and mixed with the backhoe. (Fig. 5)

On some plots gypsum was applied in the chisel track to a depth of 2 feet. (Fig. 6)

HOG PRICES at Illinois Country Markets

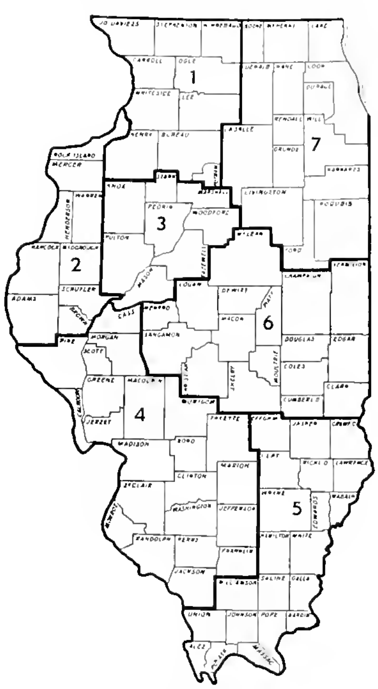
With the large number of country markets now available to the hog producer, exact price information is hard to get

EMER E. BROADBENT, ALBERT G. MADSEN, and VINCENT I. WEST

INEXACT AND CONFUSING price information could cost Illinois hog producers as much as $5,000,000 a year. This conclusion is reached after studying price differences among 106 country markets.

The shift from a central marketing system to a country marketing system has resulted in a wider price range than in the past. It has also increased the difficulty of obtaining accurate price information. Price schedules set up by local markets are not reflected in news quotations from the U.S. Department of Agriculture, which usually originate at terminal markets. Even the prices posted at country markets are not necessarily those actually paid.

About 175 country markets are scattered throughout the state, nearly all operated by dealers, order buyers, or packers. Four order-buying firms and about 10 packers buy most of the hogs sold at these markets.



Areas of state used in this study.

Order-buying firms buy hogs to fill out-of-state orders. Every day the central offices of these organizations accumulate orders for specified kinds of hogs. The firms then telephone or radio pricing and shipping instructions to their own country markets or to local dealers. Loads of hogs are concentrated in the country, and are shipped to packers at the end of the day.

106 markets studied

For the 106-market study, the state was divided into seven areas on the basis of livestock concentration, dominant marketing system, and similarity of production enterprises. This permitted price comparisons between areas as well as within areas.

Detailed purchase invoices for five 2-week periods were obtained from the 106 markets. During these time periods, the markets handled more than 30,000 lots of hogs. Invoices showed the number of hogs sold each day, their weights, and prices per hundredweight. Analyses had to be based on price and weight because there was no way of identifying quality.

Marketing charges such as yardage and commission were deducted from the price of each lot to calculate a net price per hundredweight. Since the farmer absorbs the cost of transportation, "net price" is simply the price at the weighing point. Most hogs were weighed and priced as they came off the truck, and no allowance was made for shrinkage.

Average net prices were computed for each 10-pound butcher weight class as well as for classes of 180 to 200, 200 to 220, 220 to 240, and 240 to 270 pounds. The average price paid for 200- to 220-pound hogs was used as the base price in this study.

Prices by weight and lot size

Highest average prices, $14.43 per hundredweight, were paid for 200- to 220-pound hogs. Prices for the other weight classes were 14 to 51 cents lower. Hogs in the 180- to 200-pound range brought an average of $14.28; in the 220- to 240-pound range, $14.29; and in the 240- to 270-pound range, $13.92.

Over 20 percent of the lots with 1 to 4 hogs, and 7 percent of the lots with 5 to 9 head were discounted 80 cents or more. Average discount for small lots was 16 cents a hundredweight. Of the large lots (more than 100 head), only 4 percent were discounted 40 cents or more; 76 percent sold within 20 cents of the base price; and 49 percent within 10 cents.

Month and day of week

Highest average prices were paid for all weights in June; lowest prices in December. The 240- to 270-pound hogs brought the lowest prices, relative to the other weights, in June, when the proportion of large hogs was greatest. Price differentials among the weight classes were least in September, when the proportions of light and heavy hogs were lowest in relation to intermediate weights.

Hog prices were lower on Friday than on other days. Prices were 6 cents a hundredweight higher on Monday than on Friday, and 2 cents higher on Wednesday than on Friday.

Over 24 percent of the hogs were marketed on Monday; 19.7 percent on Tuesday; 17.9 percent on Wednesday; 17.4 percent on Thursday; and 20.8 percent on Friday. Price

differences were not large enough to encourage much change in the flow to market.

Price differences by area

Significant price differences existed among the seven market areas. Highest prices were reported in Area 7, and the next highest prices in Area 5. Area 2 had the lowest prices; Area 1, the next lowest.

Average volume of sales was larger in Areas 1, 2, and 3 than in other areas of the state. Areas 4 and 5 had a relatively small hog population, which was associated with small droves.

In the state as a whole, most transactions were in lots of 1 to 10 head. Lots this small were priced significantly lower than larger lots in all areas. Largest discounts for small lots were in Area 5; smallest discounts, in Area 2. Only in Areas 4 and 5 did extremely large lots bring prices significantly higher than the base price.

In all areas, 200- to 220-pound hogs brought higher prices than did any other weight class. Highest average prices for heavier hogs were paid in Area 7. The price spread among the various weight classes was smaller in this area than in other areas. Area 5 had the lowest average prices for the heavier butcher hogs.

Producers could anticipate receiving 18 cents more for each 220- to 240-pound hog sold in Area 2 than in Area 1, but they could also expect to receive 36 cents less for a 180- to 220-pound hog. A heavy 240- to 270-pound hog sold for 92 cents more in Area 7 than in Area 5.

Throughout the state, lightweight, 180- to 200-pound hogs tended to be discounted more than medium, 220- to 240-pound hogs. There was no uniform discount, however, for the different weight classes.

Pricing by three types of buyer

Order buyers bought a slightly smaller proportion of 200- to 220-pound hogs and a larger proportion of heavier hogs than did packer buyers. Auctions handled larger proportions of both light and heavy hogs than either packer or order buyers. Packer buyers, on the average, paid 2.4 cents per hundredweight more than order buyers, and auctions paid 5.3 cents more than packer buyers.

Higher prices per hundredweight do not always mean more dollars per hog, if one must sell fewer pounds. Hogs sold at auctions were usually held several hours after unloading and were weighed after they were sold. Sorting, holding, penning, and driving may cause a shrinkage of 2 to 3 percent from the time hogs are first unloaded until they are sold and weighed. On the other hand, packer or order-buyer markets weighed hogs directly on arrival.

Prices at selected markets

Farmers can profit by knowing prices paid at alternative outlets, regardless of ownership or control. Markets operated by the same company will not always pay the same prices even though identical prices may be posted.

Price variations were studied in three supply areas with a 20-mile radius. One was in northwestern Illinois; one in southeastern Illinois; and one in western Illinois.

In the northwestern supply area, three markets were operated by one dealer organization, and four markets were operated by packers. Average value differences ranged from 53 cents per hog for 260- to 270-pound hogs, to $2.47 per hog for 180- to 190-pound hogs.

Of four markets in southeastern Illinois, two were operated by dealers, one was packer-operated, and the other was locally owned. Price differences varied from 22 cents to $1.05 per hog, depending on weight.

In the western area, five markets were operated by one order-buyer, five were packer-owned, and two were operated by local dealers. Price differences varied from 72 cents for 220- to 230-pound hogs, to $1.81 for 240- to 250-pound hogs.

The two dealer markets in western Illinois paid prices that differed by 5 to 81 cents per hog, depending on the weight class. Price differences at packer-operated markets varied from 10 cents to $1.09 per hog.

Posted and actual prices

Normally "setup" prices are posted at all markets to indicate a schedule of prices for different weight classes of hogs on a given day. News reporters may interpret these quotations as actual prices paid. As already mentioned, however, the prices paid may vary materially from the posted prices. To check the degree of variation, posted prices at two markets were compared with actual prices on five nonconsecutive days.

One market listed one price for each 10-pound weight class, but it usually paid 10 to 20 cents per hundredweight more than the quoted prices. Very rarely did the posted price exceed the average price paid.

At the second market, a price range was posted for each 10-pound weight class. Generally the daily average prices paid exceeded the top price quoted for a particular weight class. The difference was usually from 10 to 50 cents.

Quality not encouraged

The present price-reporting system, weight-schedule pricing, and widely varying prices provide no incentive to produce quality hogs. Unless perceptible premiums are paid for hogs of high quality and desirable weight (200 to 220 pounds), and unless these premiums are reported so that producers can understand them, the market cannot effectively guide production. Because of inadequate price differentiations, farmers are encouraged to sell at weights heavier than those which would command highest prices in an efficient market.

By paying a differential for uniform, meaty hogs, buyers can obtain increased returns from hogs which yield a relatively large proportion of high-valued cuts, and at the same time pay producers relatively low prices for lots of heterogeneous hogs.

Emer E. Broadbent is Professor of Livestock Marketing; Albert G. Madsen was formerly Research Associate in Agricultural Marketing; and Vincent I. West is Professor of Prices and Statistics.

Control of Bentgrass Diseases . . .

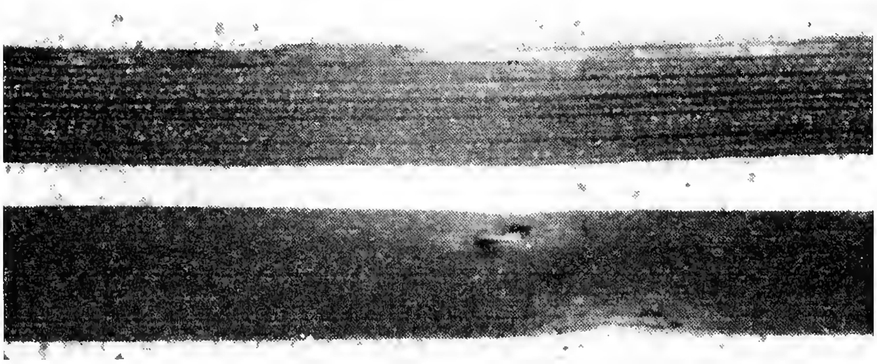
Fungicides tested for use on the golf course

M. P. BRITTON and J. D. BUTLER

A MAJOR PROBLEM plaguing the manager of a golf course is that of controlling grass diseases on putting greens, tees, and fairways. Putting greens, in particular, should be blemish-free for optimum playing conditions.

In Illinois practically all putting greens are planted to creeping bentgrass (*Agrostis palustris*). To keep the bentgrass free of disease, fungicides are generally applied every 7 to 10 days from June until September. This is the period when weather conditions are apt to favor the development of several major diseases. Fungicide protection must be renewed often because it is constantly being lost as the result of irrigation, mowing, removal of the clippings, and the growth of new grass.

Tees that are planted to bentgrasses normally receive about the same fungicide treatments as putting greens. Fairways composed of bentgrass and annual bluegrass (*Poa annua*) are often damaged by disease, but the cost of repeated fungicide application throughout the summer would be prohibitive. Consequently, fungicides are applied to fairways only when disease outbreaks have already occurred or when they appear to be imminent.



Leaf spot (caused by *Helminthosporium sorokinianum*) is one of the three major diseases of bentgrass. It may occur every summer.

Fusarium patch (caused by *Fusarium nivale*) can damage bentgrass during winter under snow or during cold, rainy spring weather.

Major diseases

The major diseases of bentgrass and annual bluegrass are caused by fungi. Three that may occur every summer are dollar spot, caused by *Sclerotinia homeocarpa;* brown patch, caused by *Rhizoctonia solani,* and leaf spot, caused by *Helminthosporium sorokinianum.* During winter under snow and during cold, rainy, spring weather, Fusarium patch (pink snow mold), caused by *Fusarium nivale,* may do considerable damage, as may gray snow mold, caused by *Typhula* spp.

One summer disease that occurs only rarely, but then with extensive damage, is called Pythium blight and is caused by species of fungi having that name.

Tests under natural conditions

Since 1961 the Departments of Plant Pathology and Horticulture have cooperated in testing fungicides for the control of these diseases. Tests have been conducted at Urbana except that tests for control of snow mold were made in Palos Park.

All plots were 3 by 8 feet. Creeping bentgrass was grown and was mowed, fertilized, and watered as if it were on a putting green. No attempt was made to induce disease development by inoculating test areas with fungus pathogens.

The occurrence of each disease on the Urbana test plots has been unpredictable and sporadic. Brown patch occurred in 1961, 1963, and 1964; leaf spot, in 1962, 1963, and

M. P. Britton is Associate Professor of Plant Pathology and J. D. Butler is Instructor in Turf Extension, Department of Horticulture.

1964. Dollar spot did not occur until 1964 and was the only disease present in 1965.

How fungicides were applied

Each fungicide or combination of fungicides was tested at the strength recommended by the manufacturer. All wettable powders or emulsifiable concentrates were applied in water with no additional wetting or sticking agent. The sprays were applied at the rate of 5 gallons of total solution per 1,000 square feet of turf and a pressure of 25 pounds per square inch. To keep the fungicide from drifting to adjacent plots during application, the solutions were applied inside a 30-inch high wind screen. All fungicide treatments were replicated at least three times except the tests at Palos Park, where space allowed only two replications.

Degree of disease incidence was rated by comparing the number of diseased spots (dollar spot, snow mold), the total area of diseased turf (brown patch), or percent of dead leaf tissue as determined visually (leaf spot).

Rating of fungicides

Fifty fungicides or combinations of fungicides have been included in the testing program. Some of the experimental chemicals were discarded after the first or second application because they damaged the grass excessively. Others were harmless to the grass, but were also nearly harmless to the fungi, and these too were discarded. Those that gave nearly complete control of one or more diseases are presented in Table 1.

A number of fungicides readily prevented the development of *brown patch* and *dollar spot* (Table 1). Fungicides containing various forms of mercury have been used to control these diseases for a number of years. Unfortunately many of these products would injure the turf unless they were applied at very low rates, especially during hot, humid weather, when disease was most likely to occur. Thiram, introduced in the 1940's, afforded better control during hot weather, particularly when it was mixed with low rates of mercury. Cadmium-containing fungicides have been used a number of years to control dollar spot and have been extremely effective.

None of these products, alone or in combination, give the desired control of *leaf spot* during severe outbreaks of the disease. During the 1950's it was observed that formulations of Actidione (an antibiotic) and zineb (a dithiocarbamate fungicide) gave somewhat better control of leaf spot. In our tests excellent control of leaf spot was obtained with Dyrene, Daconil, Difolitan, and Dithane M45, new fungicides released during or just before our testing program.

Only two fungicides, Dyrene and Daconil, controlled all three summer diseases.

The data on *snow mold* control confirmed earlier reports, and the tests were terminated after one year.

Although many excellent fungicides are available for control of the common turf diseases, little is known about the effect of fungicides on Pythium blight. Outbreaks of this disease are infrequent, but it caused extensive damage in 1955 and 1964. Much of the damage in the latter year was confined to fairways and tees, where few or no fungicide applications had been made.

Table 1. — A Comparison of Several Promising Fungicides for the Control of Four Common Diseases of Creeping Bentgrass in Illinois

Fungicide	Brown patch[a]			Dollar spot[a]		Leaf spot[a]			Snow mold, 1962[a]
	1961	1963	1964	1964	1965	1962	1963	1964	
Acti-dione Thiram	3	...	3	1	1	...	...	...	..
Caloclor	...	...	...	...	...	...	...	...	3
Chipman Mercury	...	1	...	...	..	..	.	.	...
Daconil (DAC-2787)	...	.	1	2	1	...	.	3	...
Difolitan	...	1	1	...	.	...	1	1	...
Dithane M-45	...	1	2	.	.	2	2	2	...
Dyrene	.	1	1	2	1	1	1	1	..
Kromad-Caloclor	...	...	...	...	1	...	.	.	...
Ortho Lawn and Turf	1	1	1	1	...	...	...	.	1
Panogen	...	.	..	...	...	...	.	.	2
PMA-Thiram	.	.	.	...	1	.	.	.	
Tersan OM	2	...	...	...	1	.	.	.	.
Thiram	.	...	1	1	...	.	.	.	4
Number tested	9	14	11	11	14	19	14	11	9
Number phytotoxic	1	4	2	2	1	1	4	2	0

[a] Numbers indicate the comparative ratings, with 1 being the highest. No number for a given year indicates that material was not tested.

Table 2. — Active Ingredients of Fungicide Materials Listed in Table 1

Trade or chemical name	Active ingredient
Acti-dione Thiram	0.75% Cycloheximide and 75% Thiram
Caloclor	60% Mercurous chloride and 30% mercuric chloride
Chipman Mercury	1.85% Methylmercury nitrile
Daconil (DAC-2787)	75% Tetrachloroisophthalonitrile
Difolatan	80% N - (1, 1, 2, 2,-Tetrachloroethylsulfenyl)-cis-4-cyclohexene-1,2-dicarboximide
Dithone M-45	16% Mn, 2% Zn, and 62% ethylene bisdithiocarbamate ions
Dyrene	50% 2,4-Dichloro-6-(0-chloroanilino)-s-triazine
Kromad-Caloclor	5% Calcium sebacate, 5% potassium chromate, 1% malachite green, .5% aurmine, and 16% thiram + Caloclor
Ortho Lawn and Turf	60% N-((Trichloromethyl) thio) phthalimide, 10% cadmium carbonate, and 5% thiram
Panogen	2.2% Methylmercury dicyandiamide
PMA-Thiram	10% Phenylmercuric acetate and 75% thiram
Tersan OM	45% Thiram and 10% hydroxymercurichlorophenol
Thiram	75% Bis (dimethylthiocarbamoyl) disulfide

Report on field survey and laboratory diagnoses:

MAIZE DWARF MOSAIC IN 1965

H. H. THORNBERRY

Mottling caused by maize dwarf mosaic.

ALTHOUGH maize dwarf mosaic was identified in more Illinois counties in 1965 than in 1964, we don't know for sure whether it is spreading in the state.

The disease was diagnosed in seven counties in 1964 and 14 counties in 1965. The 1964 survey was not extensive, however, and the disease could well have been more widespread than in 1965. On the other hand, we cannot be sure that all the 1964 diagnoses were correct. Most diagnoses were by late-season symptoms, which we now know are not reliable. Only in Alexander County was the disease positively identified by laboratory tests in 1964.

Occurrence in 1965

Although the 1965 survey was more extensive than the 1964 survey, it was still incomplete because of lack of help. Samples of corn from 46 counties were tested in the laboratory. The virus was found in the samples from 14 counties.

The disease was heavy in some fields in Alexander, Massac, Pope, and Union counties. Presumably it was just as serious in Pulaski County, but the virus was not found in samples collected there.

In five counties — Calhoun, Clark, Jackson, Jersey, and Randolph — the disease was moderate in some fields and not detected in others. It was light in Crawford, Hardin, Johnson, Monroe, and Scott counties.

Where the disease was severe, practically all plants were affected and grain could not profitably be harvested.

In moderately diseased fields, the crop of marketable grain was reduced by 10 percent or less. Some fields near heavily diseased areas had a surprisingly small number of diseased plants — from 1 to 10 percent. Even the diseased plants had sizeable ears. In other areas, where the disease was light, the size and number of ears were reduced very little, if at all.

Altogether, maize dwarf mosaic destroyed an estimated 185,000 bushels of corn in Illinois in 1965.

Virus reservoir plants

Johnsongrass (*Sorghum halepense* L.) continues to be the most important overwintering host for the maize dwarf mosaic virus. It was abundant near diseased corn fields in 13 of the 14 counties where the disease was identified last summer.

Another overwintering host plant was found to be gamagrass (*Tripsicum dactyloides*). A specimen collected near Belleview in Calhoun County was infected with the virus.

Plants of 24 other species, including soybeans, were tested for maize dwarf mosaic virus, but it was not found in any of the specimens.

Reliability of symptoms

One purpose of the 1965 survey was to determine what symptoms form a basis for accurate, fast field diagnosis of the disease.

Plants having field symptoms which have been associated with the disease were given infectivity tests in the laboratory. To make this kind of test, sap was expressed from a specimen that was suspected of being diseased. The expressed juice and an added abrasive were rubbed on the upper leaf surfaces of 2-week-old corn plants growing in sterilized soil in a quarantined greenhouse. Leaf mottling (mosaic) about 10 days after inoculation indicated infection by maize dwarf mosaic virus.

Mottling was the only field symptom that showed a positive correlation with the infectivity tests. In typical mottling, yellow areas are intermingled with normal green areas, usually in fine irregular streaks on young leaves or the basal portion of leaves near the top of the plant.

Yellowing, reddening, dwarfing, and ear barrenness, which are often assumed to be late-season symptoms of early infection, did not show a positive correlation with infectivity tests. The late-season symptoms and even some types of mottling may be caused by other agents than the maize dwarf mosaic virus.

In areas where the virus has been positively identified by infectivity tests or where typically mottled leaves have been found on Johnsongrass or corn, the late-season symptoms may be considered as evidence of maize dwarf mosaic. By themselves, however, they do not justify a diagnosis of the disease.

Future plans

Since we now know that typical mottling is a reliable indication of maize dwarf mosaic, we have a tool for rapid, accurate field diagnoses. We hope to get complete information on disease distribution and severity next summer, its spread during the season, and crop losses.

Laboratory work will also continue. Present plans call for infectivity tests of diseased specimens, assessment of different hybrids and crosses for resistance to maize dwarf mosaic, and tests to determine if roots of infected plants are susceptible to soil microorganisms.

H. H. Thornberry is Professor of Plant Pathology. The author wishes to acknowledge the assistance of Alan G. Otterbacher, Mary Ruth Thompson, and others who assisted in the 1965 survey.

From this . . .

. . . to this?

Farmers' Experiences With Narrow-Row Corn

D. R. HICKS, W. O. SCOTT, and J. W. PENDLETON

PEOPLE all over the state have been asking questions about the experiences of farmers who grew corn in narrow rows last year. It was the first year that machinery for narrow-row corn was commercially available.

We at the University have particularly wanted to know how on-the-farm experiences compared with results on research plots, which are admittedly small in number and size. During the past three years, plots with narrow rows have yielded about 5 percent more corn and 10 to 15 percent more soybeans than plots with conventional rows. Were the corn yields obtained in actual farm practice similar to those on our plots?

To answer this and other questions, we first asked farm advisers for the names and addresses of farmers in their counties who had grown corn in 30-inch rows or closer during the 1965 season. We received a list of 303 names. At the end of November we mailed a four-page questionnaire to every farmer on the list. By December 10 we had received 221 replies.

Of the farmers who responded to this questionnaire, about 25 percent owned all of their land and 25 percent were tenants. The other 50 percent rented part and owned part of the land they farmed. Half of the farmers were between 36 and 50 years of age; one-fourth were over 50 and one-fourth under 36.

This group of 221 farmers had an average of 269 acres in narrow-row corn. The range was from 30 to 1,200 acres. Eighty-five percent of the farmers converted their total corn acreage to narrow-row planting. One farmer had been growing corn in narrow rows for eight years, but 95 percent of the group adopted this practice for the first time last year.

Average yield of their best narrow-row fields was 153 bushels per acre; average yield for all narrow-row corn was 132 bushels. Fifty-six of the farmers had test plots of conventionally spaced corn so that they could compare yields with those from narrow-row corn. These farmers reported an average increase of 6.6 percent for narrow rows. Increases according to size of farm were as follows:

Size of farm	*Pct. increase*
100-199 A.	4.7
200-399 A.	6.3
400-599 A.	5.0
600 A. and over	8.5

Plant populations ranged from 16,000 to over 25,000 plants per acre, and were above 20,000 on 70 percent of the narrow-row acreage. Eighty-one percent of the farmers reported that standability of narrow-row corn was as good as that of corn in conventional rows.

Farmers were asked if they encountered problems that were unique to narrow-row production. Here is a summary of their answers:

Field operation	*Pct. yes*	*Pct. no*
Planting	10	90
Fertilizer application	15	85
Cultivation	15	85
Harvesting	13	87

The farmers were almost unanimous in asking for shorter corn hybrids in the future.

Our "64 dollar question" was the last one: "Would you recommend narrow-row corn to your neighbor?" Of those who answered this question, 85 percent said yes. Others would not answer yes or no, but said that the decision depended on the neighbor's skill as a farmer, his corn and soybean acreage, and the status of his present machinery.

D. R. Hicks is Assistant in Agronomy; W. O. Scott, Professor of Crops Extension; and J. W. Pendleton, Professor of Agronomy. The authors want to thank all those who took the time to complete the questionnaire.

ARTIFICIAL RAINFALL Is Used to Measure Infiltration Rates

G. D. BUBENZER and B. A. JONES, JR.

A "RAINMAKING" MACHINE has helped to determine infiltration rates on three Illinois soils — Flanagan, Cisne, and Elliott silt loams.

While the machine, known as an infiltrometer, doesn't create rain, it does apply water in such a way as to simulate rainfall. It thus permits us to determine infiltration rates under natural conditions. Other types of infiltrometers apply water by flooding, rather than in a rain-like spray.

Water, at the rate of about 4 inches per hour, was applied to plots about 3¾ feet square. Before each test, the exact application rate was determined by covering the plot with a calibration pan and then measuring the amount of simulated rainfall in a given time.

During the tests, the rate of runoff from each plot was measured with a water stage recorder. Infiltration rate was determined as the difference between the application rate and the runoff rate. Initial and final moisture contents, bulk density, and soil temperatures were also determined for each test condition. Soil profile descriptions were obtained at each soil location.

Two crops — third-year corn and a grass-legume mixture — were grown on all three soil types to test their effects on infiltration. First-year corn was also tested on Elliott silt loam. Infiltration was measured on the corn plots both before and after cultivation. The grass-legume cover was clipped to a height of about 3 inches before testing.

Two tests, long enough to allow at least 10 minutes of steady runoff, were conducted on each plot. The first, or dry test was made with the natural soil-moisture conditions existing at the time of the testing. A second, or wet test was made 24 hours later. The primary purpose of the dry run was to establish a uniform moisture condition on all plots. With the wet run it was then possible to determine the equilibrium infiltration rate for each test condition. The equilibrium infiltration rate is the rate at which infiltration levels off after a period of time.

A significant difference in equilibrium infiltration rates of the three soils was observed. Following is the mean rate for all treatments on each soil, together with the 80-percent confidence interval (the range within which one would expect to find the infiltration rate 80 percent of the time).

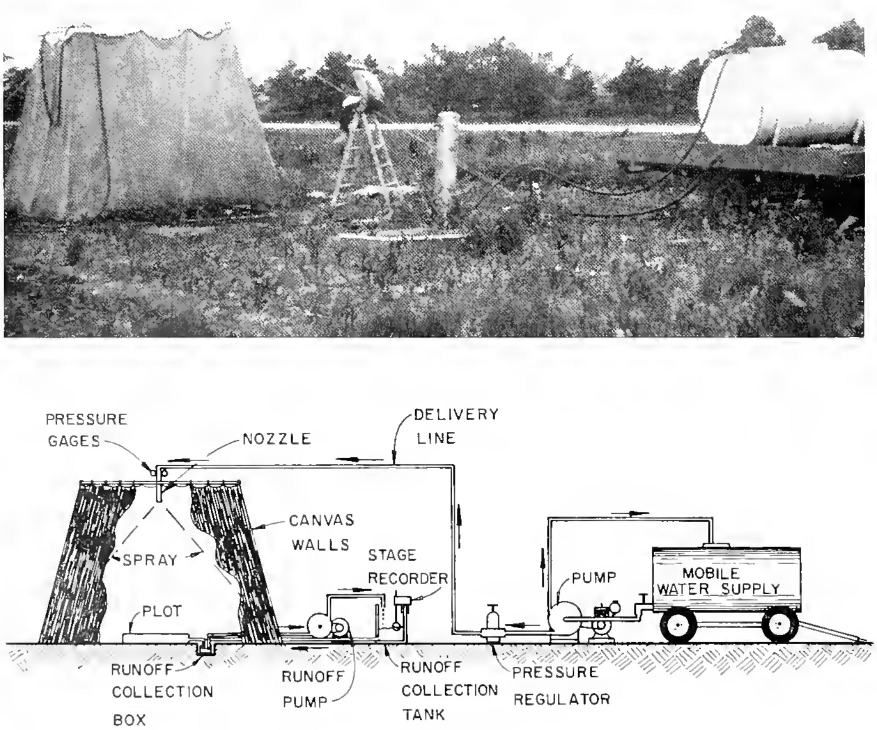
Soil	*Mean rate, in./hr.*	*80% confidence interval*
Cisne silt loam......	0.6	0.7-0.5
Elliott silt loam.....	1.5	1.7-1.3
Flanagan silt loam...	2.1	2.4-1.8

On Elliott and Cisne silt loams, the infiltration rate did not vary significantly for the different treatments. Infiltration was significantly greater, however, on the Flanagan sod plots than on the other Flanagan plots. The reason for the exceptionally high infiltration rate on the Flanagan sod is not known.

Infiltration tended to be greater on the plots with first-year corn following alfalfa than on the third-year corn plots. This tendency was much more apparent before cultivation, as shown by the mean equilibrium infiltration rates below.

Treatment	*Infiltration rate, in./hr.* 1st-year corn	3rd-year corn
Before cultivation	2.0	1.5
After cultivation	1.2	1.1

Results of this study will be combined with those obtained from the other North Central states and will be published in a regional bulletin.



Photograph and diagram of the sprinkling infiltrometer.

G. D. Bubenzer is Instructor in Agricultural Engineering and B. A. Jones, Jr., is Professor of Agricultural Engineering.

HOW CHANGES in Moisture Content Affect Durability of 5-Ply FURNITURE PANELS

J. K. GUIHER

FURNITURE in American homes is exposed to a wide range of humidities and temperatures. Moisture content of furniture may be as low as 4 percent in the arid southwest, and as high as 12 percent or more in the humid southeast. In the midwest, furniture may dry out in winter, when furnaces are running, and reach a high moisture content in summer, when windows are open and the air is damp.

Year-round air conditioning, including humidity control, would prevent wide fluctuations in furniture moisture content from season to season, and would assure damage-free furniture. It would be better, however, for the manufacturer to build furniture with a high resistance to moisture variation.

Among the furniture parts that need special attention are tops, doors, and drawer fronts. Very often these parts are fabricated from 5-ply lumber core panels, consisting of a solid core of a utility wood such as yellow poplar, ½ to ¾ inch thick, with two sheets of veneer glued to either side.

The core usually is made by edge-gluing 3-inch strips to the desired width. The sheets of veneer next to the core are called crossbands. Their grain direction is perpendicular to that of the core. The expensive, usually highly figured layers of veneer on the outside of the panel are face plies. Grain direction is parallel to that of the core. Panels can be bonded flat or curved.

The highest stresses develop in the core when its moisture content changes, with consequent swelling and shrinking. A panel may have a moisture content of 12 percent, for example, when the crossbands and face plies are bonded to the core and then may be used in a piece of furniture that finally has a moisture content of 4 percent. The resulting stresses may cause the panel to fail in the vicinity of the core-crossband glue line.

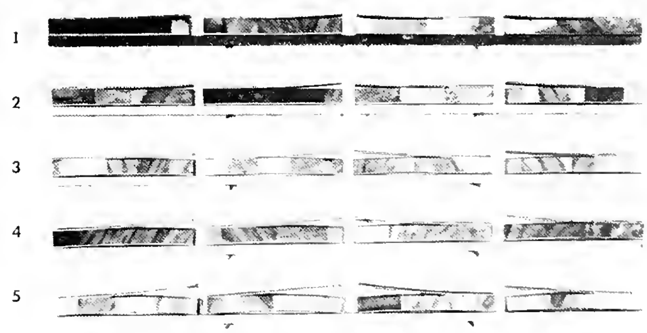
Research was conducted to find a moisture content for cores that will assure a minimum stress in panels under all conditions of indoor use. Twenty 5-ply panels were fabricated at five different moisture contents: 12, 9, 7, 5, and 3 percent. Four panels were in each group. Panels were flat when bonded and would be expected to be flat again if moisture content changed and then returned to its original level.

J. K. Guiher is Assistant Professor of Wood Technology and Utilization, Department of Forestry.

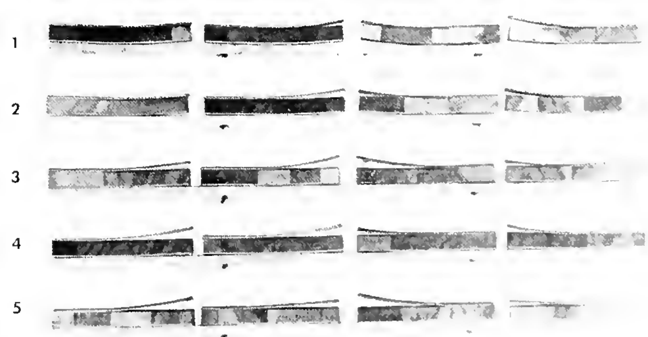
Panels were about 1 inch thick and 8 inches wide. Each was cut into 1-inch sections across the grain of the core. Sections were sawed along the core-crossband glue line for part of the 8-inch width. This exposed part of the core and allowed unrestricted swelling and shrinking of one side of the core as moisture changed.

Figure 1 shows sections from all panels after they were conditioned to 12 percent moisture. Those in Row 1, which were fabricated at 12 percent moisture, are flat as would be expected. Those in Row 5, which started at a moisture content of 3 percent, are quite warped. Figure 2 shows the same sections as Figure 1, but at 3 percent moisture content. Now the sections in Row 5 are flat, while those in Row 1 are warped. The stresses indicated in Row 5, Figure 1, and in Row 1, Figure 2, are enough to damage the panels.

In both figures, the sections in Row 3 had a moisture content of 7 percent when bonded. Neither an increase to 12 percent moisture nor a decrease to 3 percent caused enough warping to damage the panel. It can be concluded that if cores are manufactured with a 7- to 9-percent moisture content, including moisture added by the adhesive, the moisture content of the completed panel could drop to 4 percent in Arizona or rise to 12 percent in New Orleans without damage to the panel.



Panel sections at a moisture content of 12 percent. Sections in row 1 had been fabricated at a moisture content of 12 percent; row 2, at 9 percent; row 3, at 7 percent; row 4, at 5 percent; and row 5, at 3 percent. (Fig. 1)



Panel sections at a moisture content of 3 percent. For initial moisture contents, see caption for Figure 1. (Fig. 2)

"FOCUS ON LINE AND DESIGN"

A self-teaching program of the Cooperative Extension Service

JOHN BEHRENS

THE STREAMLINED TWINS shown at right are fast becoming the trademark for a package of new teaching tools being introduced by the Cooperative Extension Service.

This package of materials, "Focus on Line and Design," reflects the growing use of an educational technique called programed instruction. This technique is not new. It was introduced in the 1930's, but it was not extensively developed until the 1960's.

In programed instruction, the learner is presented with a carefully designed sequence of facts, or bits of information. Programmers refer to each step in the sequence as a "frame." Frames may be presented through one or more media — a book or pamphlet, a movie, a set of slides, an audio tape, or a teaching machine. The important thing is that the student gives an active response to each frame before moving on to the next one. The response may be given orally, in writing, or by pressing a button on a teaching machine. In any event, the student knows at once whether his answer is right. With programed materials, the student can move at his own pace and convenience.

Programed instruction has been used for Extension programs in other states, but it has been mostly confined to in-service training and orientation. "Focus on Line and Design" represents one of the first efforts anywhere to use programed instruction for Extension teaching in the counties.

The idea for "Focus on Line and Design" developed when the Extension clothing specialists proposed a slide set as a sequel to a set they had already developed — "Focus on Fit." Conferences of editors, artists, and clothing specialists indicated that the subject matter could be presented in a multipurpose package of teaching materials.

A set of 89 color slides was prepared, giving the principles of line and design as applied to clothing construction and use. These slides, with their explanatory script, can be used by a professional home economist to teach principles of clothing design. Every home adviser in the state has received a set of slides.

Since home economics Extension lessons are often presented by local leaders who are not professional home economists, an audio tape describing the material was prepared to accompany the slides. This combination of materials can also be used by an individual student for private instruction.

Finally, a programed instruction manual is being prepared. A trial printing of the manual has already been made and tested with a group of 4-H girls and a group of homemakers in Champaign County. The manual is being revised and improved as a result of these tests, and a final printing will be distributed later this year.

"Focus on Line and Design" is, we hope, only the beginning in the use of programed instruction by the Cooperative Extension Service. A package of materials for self-teaching in home landscaping is now being planned. Eventually such packages may well be developed for many of the present Extension programs.

Clothing specialists Esther Siemen and Marjorie Sohn confer with artists Carol Isberg and Kenneth Cessna concerning preparation of programed materials.

John Behrens is Assistant Professor of Agricultural Communications.

Soybean Meal Increases Swine's Need for Zinc

Until a decade ago nutritional scientists regarded zinc as an interesting mineral, required in the diet of animals, but of no practical concern since it was presumed to be abundant in natural feeds. Thus the discovery in 1955 that swine on typical midwest corn-soybean meal diets were likely to suffer from zinc deficiency came as a surprise.

Experiments in the Department of Animal Science have been devoted to finding out why the pig needs more zinc than we previously believed. Initially we conducted experiments with pigs fed purified diets to determine that we were actually dealing with a zinc deficiency. Once this was done, we employed rats and chicks for our investigations, since they are more convenient tools. We were able to demonstrate that zinc needs of animals are higher when the diet contains soybean protein than when it contains casein or egg as the protein source, and that the reason for this difference is a less complete absorption of zinc from the soy-protein diet.

In the meantime other investigators had shown that symptoms of zinc deficiency are increased when phytic acid is added to diets. Phytic acid is a substance present in plant products, but not in animal products. Again resorting to purified diets, we demonstrated that phytic acid will decrease the animal's absorption of zinc from the diet. Our experiments have further shown that the effect of phytic acid is increased when the diet contains more calcium than the animal needs. In the absence of phytic acid, high calcium intakes do not interfere with zinc absorption.

The interference of calcium and phytic acid with zinc absorption is less obvious when starch rather than glucose provides the dietary carbohydrate. In our current studies we are therefore investigating the way in which zinc utilization is affected by the source of dietary carbohydrate. — *R. M. Forbes*

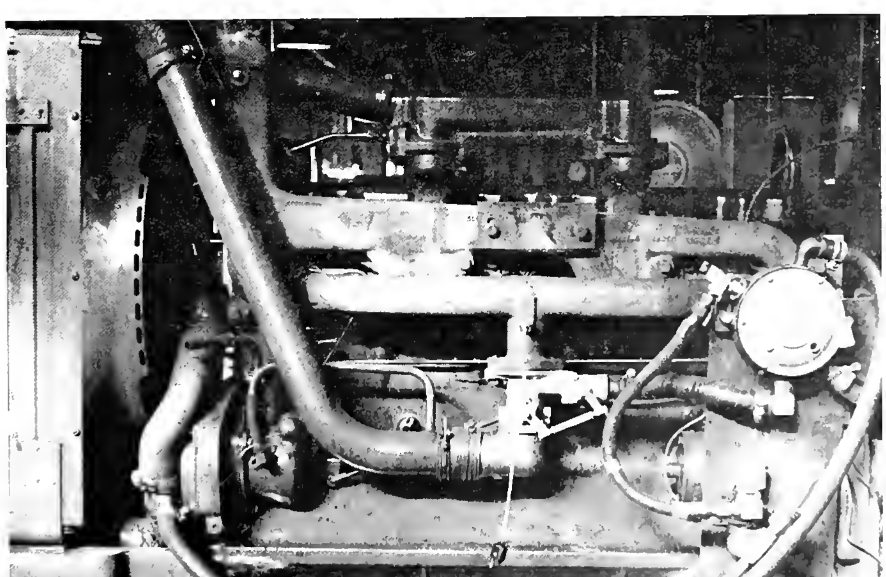
Performance of Tractor Engines After Conversion From Gasoline to L-P Fuel

What performance can a farmer expect from his gasoline tractor if he converts it for the use of liquefied petroleum fuel? A study in the Department of Agricultural Engineering indicates that the performance of the converted tractor depends upon three things: selection of the proper compression ratio, intake manifolding, and spark timing.

Propane has a greater octane rating than regular gasoline. Higher compression ratios are therefore necessary to obtain the maximum benefit from propane and to achieve as much power output as is obtained from gasoline. According to our tests, the compression ratio of the engine had to be increased numerically about 1.5 above the original compression ratio of the gasoline engine. Any additional increase gave only a small increase in horsepower and fuel efficiency. As the compression ratio was increased, the spark advance at full load had to be retarded to burn the L-P fuel mixture properly.

The change in manifolding is required because of the fuel and carburetor characteristics. When gasoline is the fuel, a wet fuel-air mixture, containing fuel droplets, enters the manifold. Heat must be added to insure evaporation of the droplets and proper distribution of the mixture in the manifold. When propane is the fuel, the fuel-air mixture is dry, without any fuel droplets. If heat is added to the manifold, it will reduce the unit charge delivered to the cylinder and cause a loss in power output. The intake manifold must therefore be cooled by isolating it from the exhaust manifold.

There are two possible ways of changing the manifolding. Either the original gasoline manifold can be isolated from the exhaust manifold by removing the heat exchanger, or a manifold designed specifically for L-P gas can be installed. In our studies, the two methods produced about the same amount of horsepower. They differed, however, in fuel efficiency,



Gasoline tractor engine with an LP-gas conversion unit installed.

which was much better at all load conditions when the L-P manifold was used. The probable explanation is that the L-P manifold is designed to distribute the dry fuel mixture better than the modified gasoline manifold, and so each cylinder receives a more desirable fuel-air mixture.

Future tests will be conducted to determine the effects of (1) changing the air cleaner restriction on the engine, (2) not cooling the intake manifold, and (3) changing the spark advance characteristics of the distributor at part load. — *M. L. Janssen and R. R. Yoerger*

The Role of Certain Bacteria *(Escherichia coli)* in Diarrhea of Swine

Many swine producers have suffered losses due to diarrhea in nursing or recently weaned pigs. Diarrhea may kill the pigs or cause them to remain unthrifty after they recover. There are many causes of diarrhea — bacteria, viruses, deficient rations or housing. One cause now being investigated at the University of Illinois is a group of bacteria known as *Escherichia coli.* These bacteria are normal inhabitants of the intestine. However, certain types of *E. coli* have been found to be associated with diarrhea, and a few research workers have reproduced diarrhea by feeding such *E. coli.*

Since 1960 we have been typing *E. coli* isolated from pigs in herds with a diarrhea problem. Our purpose is to identify any types which are particularly associated with diarrhea in this area. Because a wide variety of *E. coli* types is usually present in a group of animals, several animals must be examined and a large sample of *E. coli* isolates must be typed before one can determine whether there is any type present that might be causing disease.

So far we have identified two types which were associated with diarrhea problems: 08:K85:H19, found in six herds, and 0138:K81:-NM, found in two herds. Other types have been partially identified. In a given outbreak, one of these types will predominate in the sick pigs.

Limited observations have indicated that the *E. coli* types associated with baby pig diarrhea were not present in the gilts on pasture, but were present in the nursing sows and the dust in the farrowing house. — *Jennifer Gossling and Harry E. Rhoades*

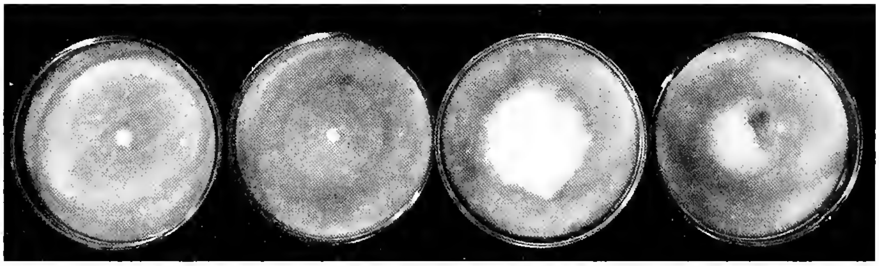
Identifying the Races of the Fungus Causing Red Stele Rot of Strawberries

Red stele rot, caused by a soil-inhabiting fungus (*Phytophthora fragariae*), is a serious menace to strawberries in both commercial and home gardens. Growing resistant varieties is the only method of control. This approach has limitations, however, since the fungus may develop physiological races which vary in pathogenicity to the different varieties.

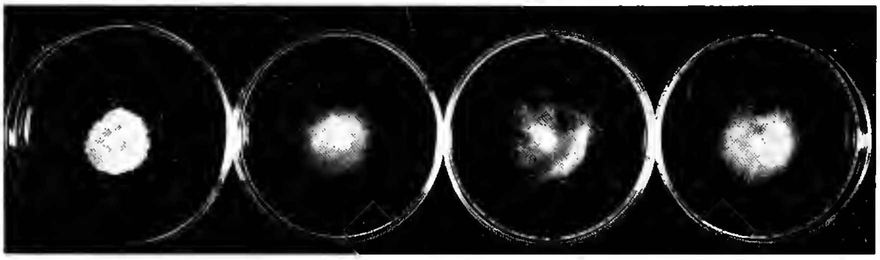
Eight races are known at present. These vary widely in distribution, only two having been found in Illinois. The common one, race A-1, is prevalent throughout the state, while race A-3 has been found only in Marion County. Thus, a variety that is resistant just to the common race can be grown in all parts of Illinois except Marion County. There we need a variety that is resistant to both race A-1 and A-3.

The eight known races have been identified by their differential host response. Recently races A-1, A-2, A-3, and A-4 were identified by laboratory procedures in the Department of Plant Pathology. When cultures of these races were grown on different artificial media, race A-1 was separated from A-3, and both were differentiated from A-2 and A-4. Race A-1 grew more rapidly on both frozen lima bean agar and a basal medium than on the other media. Also, it produced a more compact type of mycelial growth than did the other three races. Race A-3 produced a distinctive, very fluffy mycelial growth on agar media.

On differential media, races A-2 and A-4 were very similar in growth, both growing more slowly than A-1 or A-3. By using different sources of either carbon or nitrogen in the basal



Seventeen-day-old cultures of the races A-1, A-2, A-3, and A-4 of *P. fragariae* on frozen lima-bean agar medium at 20° C.



Types of mycelial growth of races A-1 (compact), A-2, A-3, and A-4 (loose) of *P. fragariae* in basal liquid medium at 20° C.

medium, it was possible to separate races A-2 and A-4. Race A-2 accepted mannose as the carbon source and DL-tyrosine as the nitrogen source, while race A-4 utilized glycerol (carbon source) and L-alanine (nitrogen source) exceptionally well.

In cooperation with the Department of Veterinary Physiology and Pharmacology, we have used serology in preliminary studies of these four races, with promising results. Also, we have had encouraging results from the use of disc electrophoresis to compare protein samples of these races. — *Dwight Powell and H. S. Gill*

Relationship Between the Weather and Survival of Sheep Parasites on Pastures

Certain types of roundworms, which are frequently parasitic in the intestine of young lambs, constitute a major problem to the Illinois sheep industry. Adult female worms produce microscopic eggs which pass to the external environment with the droppings. On the ground, the eggs hatch and develop into microscopic infective larvae. These larvae migrate upward on the pasture grass and may later be eaten by grazing farm animals. The parasites establish themselves in the new host, grow to the adult stage, and repeat the cycle.

While the eggs and larvae are outside the host animal, they are subject to adverse weather conditions. Some species are relatively resistant to environmental changes, while others are killed rapidly by abnormally high or low temperatures, direct sunlight, or extreme dryness.

Scientists at the College of Veterinary Medicine are currently engaged in studying the ecology of some of these parasitic worms, in an attempt to learn just how such environmental factors as temperature, sunlight, rain or snow, wind, moisture, evaporation, and dew duration affect the development and survival of the eggs and larvae. Meteorologic conditions are measured at or near the ground surface of experimental pasture plots, and the resulting data are compiled with the aid of computers. Eventually these data will be correlated with the number of eggs and larvae collected from the plots throughout the year.

Such investigations should ultimately lead to improved predictions of the potential parasite hazard for each season, and should be of considerable value in helping farmers establish effective worm-control programs. — *Ferron L. Andersen and Norman D. Levine*

Milk Fat Is Important Source of Flavor for Cheddar Cheese

The proteins of milk (especially casein), milk sugar, and milk fat are the precursors for the flavor compounds which give Cheddar cheese its characteristic flavor. Milk fat is relatively more important than the other two components, as Cheddar cheese made from skimmilk without fat does not develop a characteristic Cheddar flavor.

Further evidence that milk fat has a unique role in flavor development was demonstrated by experiments in which cheese was made from different lots of milk containing different percentages of fat, ranging from 1 percent to 4.5 percent. Flavor improved as the fat content of the cheese increased to a level of 50 percent of the total solids. There seemed to be no advantage, however, in having greater amounts as far as flavor was concerned.

Hydrolysis of fat and formation of acetate salts are chemical changes which are at least partially responsible for the role fat has in flavor development.

Final flavor in cheese results from a balance of components. When fat hydrolysis was at either a very low or a very high level, undesirable flavors resulted. Moreover, if acetate production was either suppressed or was excessive, undesirable flavors were also produced. The best flavor resulted when fat hydrolysis was controlled so that the ratio of free fatty acids to acetate was within the range of 0.55 to 1.0, and the sum of free fatty acids plus acetate was within the range of 12 to 28 micromoles of acid per gram of cheese solids after 6 months of ripening.

Some diet faddists tend to depreciate the value of fat in the diet, but some foods do not develop a normal flavor without it. Cheddar cheese is one of those foods. — *S. L. Tuckey and J. A. Ohren*

Agglutination Test for Detecting the Virus of Ovine Abortion

The virus of ovine abortion is a member of the so-called Psittacosis-Lymphogranuloma venereum (PL) group of viruses. These agents, larger than most viruses, are of considerable importance in both human and veterinary medicine. Diagnosis of the diseases caused by PL viruses is generally based on the detection of antibodies in the blood serum of suspected individuals. Therefore, improved serologic tests for PL viruses are constantly being sought.

In the present work, the virus of ovine abortion was propagated in the yolk sac of chicken embryos. The virus-rich yolk was then treated with a high concentration of dipotassium phosphate, which precipitated the virus but not some of the yolk impurities. The precipitate was further purified by treating it with Genetron, a fluorocarbon of the type used in refrigerators. The treatment yielded a relatively pure preparation, in which virus particles could be seen with the aid of a microscope. When the preparation was mixed with the serum of ewes which had aborted, the virus particles became agglutinated (formed clumps), thus indicating the presence of antibodies in the serum.

Comparison of the agglutination test with the complement fixation test (another, more conventional serologic procedure) showed that the former was both more sensitive and simpler to perform. — *D. Segre and B. Mendlowski*

FARM BUSINESS TRENDS

Every family must make highly important choices from time to time. Farm families, being engaged in a highly competitive and rapidly changing business, have more critical choices to make than most other families. A farmer's decisions often involve investments of many thousands of dollars and influence family income for years to come. Those who most clearly perceive the trends of their time will have the best chance of making profitable and satisfying decisions. Some of the more important trends are discussed in the following paragraphs.

Employment opportunities. Manpower needs in farming are decreasing as land holdings are combined to provide larger operating units. Many families will be left without farms and will have to change occupations in midlife. Four-fifths, or more, of the boys now growing up on farms will not be able to find good opportunities in farming. Opportunities are increasing, however, for employment in farm-related businesses. Younger men with college educations, or the equivalent, will have their choice of many jobs.

Producing grain for sale. Producing corn and soybeans for sale are the most profitable and the fastest growing major farm enterprises in the Midwest. The trend toward cash grain production seems likely to continue for a long time. The central Midwest, especially Illinois, is well adapted to the production of grain for sale. It has an abundance of rich, level land, favorable rainfall and temperature, and cheap water transportation to foreign markets, which are expanding rapidly.

Specialization in poultry and livestock. The production of poultry and eggs has become a specialized large-scale factory-like operation on many farms. The cattle-feeding and dairy industries are developing in a similar manner, especially in the West. Hog production could follow whenever disease-control problems are solved. Exceptional managerial ability is required for success in large livestock enterprises. Some failures are inevitable.

The dairy and poultry industries in Illinois have been declining for several years. Cattle feeding has increased, but not as fast as in the country as a whole. For many years hog production increased faster in Illinois than in the rest of the country, but recently Illinois's share of the nation's hog business has decreased slightly.

Farm ownership. A modern Midwest "family" farm and its equipment cost $100,000 to $500,000. This is considerably more than an average man can accumulate in a lifetime — in farming or other employment. High and progressive income taxes, as well as taxes for Social Security and Medicare, cut into farmers' land-buying ability. Few families who start from scratch can buy and pay for a farm. Those who do not inherit farms will operate land owned by other individuals or corporations. These farmers will put their savings into nonfarm investments.

Range of farm earnings. As farming units become larger and competition grows stronger, the spread between top and bottom incomes is becoming greater. The differences in income will depend less upon hard physical labor and more upon what is commonly called management. Management consists of deciding what should be done and how to do it, and getting it done properly and on time. It is that part of farming which is done with the head, not with the hands. — *L. H. Simerl*

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Spring, 1966

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

If foxtail isn't controlled at planting time, it can take over a field. Give corn or soybeans a head start of at least 3 weeks, however, and weeds will do little damage (page 8).

Volume 8, Number 2 **COLLEGE OF AGRICULTURE** **URBANA, ILLINOIS**

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CONTENTS

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NEWS AND VIEWS

Agricultural Research — A Study of Interactions

AGRICULTURE is fundamentally based on the use of natural resources to meet human needs. As experience and research have increased our knowledge of natural resources and of the plant and animal products they make possible, so also our capacity for managing these resources and products has grown.

One of the great generalizations that has emerged from the study of agricultural production is the principle of interactions. It stems from the fact that the results produced by complex systems, such as a field of corn, a herd of cattle, or a farm business, depend upon many interdependent factors. The individual effect of each one factor is strongly influenced by many, if not all, of the others.

Because of this great interdependence, it is impossible to fully understand a complex system by studying its response to changes in only one factor. Rarely if ever, however, can one investigator, or even a team of investigators, study simultaneously the individual and combined effects of all the factors that affect the whole system. The usual research strategy is to study selected parts of the whole system in appropriate detail. Then, as knowledge of the subunits grows, the whole system is gradually reassembled from its parts. A wide variety of scientific skills is required to unravel the intricate details of the various subunits. There is thus increasing need for interdisciplinary cooperation in the resynthesis of the whole system from its components.

Recent developments in automated techniques of measurement and in the high-speed processing of numerical data have greatly increased our ability to collect and process data on complex systems. Great need exists, however, for adequate conceptual models that will provide a suitable framework for the reassembly of whole systems. In agriculture, as in other fields of applied science, our ability to solve the many problems of an increasingly complex and interdependent society will largely depend on our resynthesis of highly interacting systems from a growing stockpile of knowledge concerning the component subsystems. — *M. B. Russell*

Some achievements of the EUROPEAN COMMON MARKET

The prosperity of Common Market countries, after eight years of economic integration, justifies a hopeful view of the future

R. W. BARTLETT

ONE OF THE most important things which have occurred in this century to improve living standards and promote peace in Europe has been the organization and development of the European Common Market.

Also known as the European Economic Community (EEC), the European Common Market includes Belgium, France, Italy, Luxembourg, Netherlands, and West Germany. The economic integration of these six countries is all the more remarkable when we remember that three major wars have been fought in Europe since 1870 and that the last one ended just a little over 20 years ago.

Beginning of EEC

The EEC grew out of the European Coal and Steel Community (ECSC), which came into being in 1953 and under which all trade barriers on coal and steel among the six countries were eliminated. The success of the ECSC paved the way for ratification of the Rome Treaty by the six parliaments in 1957. Under the provisions of this treaty, the EEC became a reality in 1958.

One provision of the treaty called for a series of tariff reductions that would break down all trade barriers among these countries by 1970. By January of this year, tariffs among these countries had been reduced by 80 percent — which is well ahead of the timetable set forth in the treaty.

Under other provisions of the treaty, a market structure was set up. This includes a Court of Justice, a Council of Ministers, an Assembly (parliament), and a Commission that carries out day-to-day operations and initiates new policies for joint consideration by the six member countries.

Since the EEC was organized, seven other European countries — Austria, Denmark, Norway, Portugal, Sweden, Switzerland, and the United Kingdom — have organized the European Free Trade Area (EFTA). While this organization calls for economic cooperation among the member countries, it does not have the same degree of economic integration that the EEC does.

Economic progress

Now that the EEC has been in operation for eight years, some logical questions occur: What progress has been made in improving the living standards of the 178 million people now in the Common Market countries? How does this compare with changes in the EFTA? Has economic integration benefited the EEC?

The purchasing power of the gross national product (GNP) in EEC and EFTA is shown in Figure 1. Following a downward trend from 1948 to 1950, which also occurred in the United States, purchasing power has grown steadily in both groups of countries. This increase has been associated with recovery from World War II and with prosperous business in other industrial countries, including the United States.

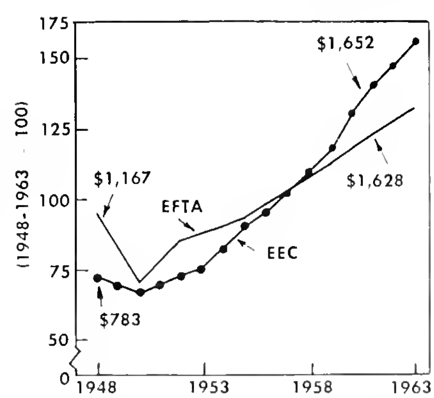
As is obvious in Figure 1, average growth has been faster in the EEC than in the EFTA. Measured in 1959 dollars, the purchasing power of GNP in EEC increased from \$781 per person in 1952, to \$1,652 in 1963. This was an increase of \$871, or 112 percent. During the same period purchasing power of GNP in EFTA grew from \$1,044 to \$1,628 per person, for an increase of \$584, or 56 percent. These figures indicate that the EEC policies of economic integration have already given tangible results in the form of better living standards than would have been likely without economic integration.

How much the individual EEC and EFTA nations shared in the overall prosperity, 1952 to 1963, is shown in Figure 2.

Our country benefits

As the EEC economy expands, its imports of U.S. goods tend to expand faster than the growth in gross national product. Between 1953 and 1964, EEC imports from the United States more than tripled, increasing from \$1.4 billion to \$4.6 billion.

Both agriculture and urban industry in the United States have benefited from the EEC. In 1964, the manufactured goods imported by the EEC from the United States were



Indexes of changes in per capita purchasing power of gross national product in the European Economic Community and European Free Trade Area, 1948-1963. (Fig. 1)

R. W. Bartlett is Professor of Agricultural Economics.

worth $3.2 billion, more than four times as much as in 1953 ($780 million). Agricultural imports more than doubled from 1953 to 1964, rising from $667 million to $1.4 billion. Imports of soybeans alone increased from $31 million in 1953 to $214 million in 1964. Further increases in import of U.S. soybeans may be expected as purchasing power in the EEC continues to grow.

The increase in annual rate of imports is more than paying the cost of the Marshall Plan. Between 1948 and 1957 about $9 billion of Marshall Plan funds were given to EEC for reconstruction and development. With the $3.2 billion increase in annual imports from 1953 to 1964, less than three years will be needed to repay the $9 billion.

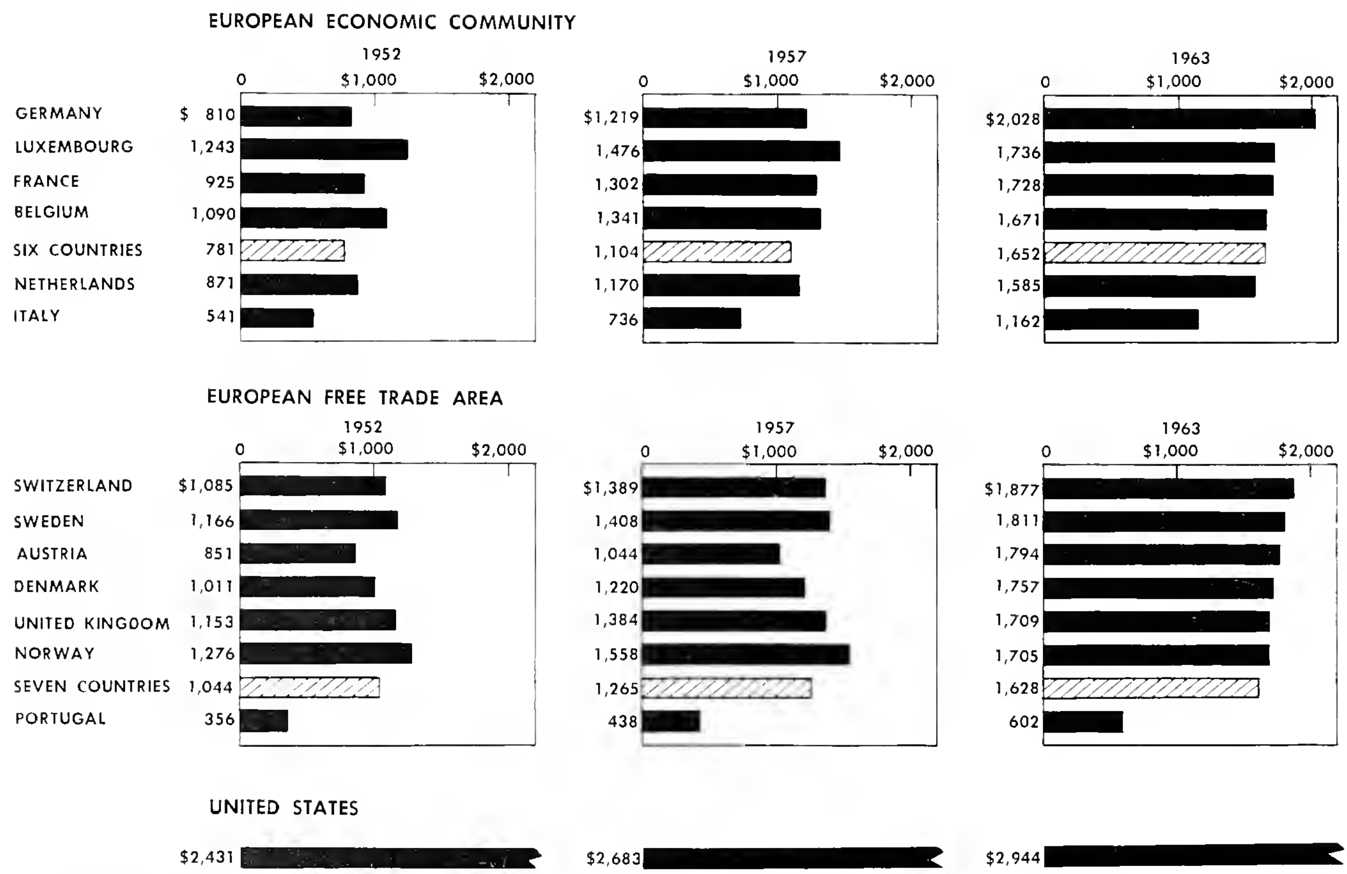
Possible future trends

As we review the history of the European Common Market, it would appear that never in history has any other group of industrial nations accomplished so much, on a peacetime basis, in such a short time. It is therefore not surprising that each of the six EEC countries is apparently committed to a continuation of the economic integration already achieved. Furthermore, five of the countries favor a more centralized control of policy, even though it means loss of some national sovereignty.

France, through President De Gaulle, has vigorously opposed centralized control. He wants national sovereignty on policy matters, as expressed by the six parliaments, rather than having policy approved by the EEC Assembly. To date the role of the EEC Assembly has been largely advisory.

This is a specific case in point: Should the billion dollar fund expected from import levies be administered in conformance with policy established by the EEC Parliament? Or should this fund be administered under the joint supervision of the six parliaments?

In January, 1966, the EEC countries agreed to continue the joint supervision of policy by the six parliaments. While this decision will unquestionably slow down future changes in the EEC, two facts should be kept in mind. First, the rapid increase in purchasing power and economic status of EEC countries has come about through the joint decisions of the six parliaments. Second, continuance of joint supervision by the six parliaments working together may possibly create an environment more favorable to admitting the United Kingdom and other EFTA countries as members or associate members of EEC. The EEC is already the third largest economic unit in the world, and the addition of some 90 million people of the EFTA would further strengthen free Europe.



Purchasing power per person (in 1959 dollars) in EEC, EFTA, and the United States, 1952, 1957, and 1963. (Fig. 2)

Effect of Soaking Time on

DURABILITY OF FENCE POSTS

C. S. WALTERS

For more than 20 years, research workers in the Department of Forestry have been periodically inspecting a group of fence posts.

The posts are eastern white pine, 7 feet long and about 4½ inches in top diameter. Before being set into fence lines, they had been peeled, seasoned, and soaked for various lengths of time in a cold solution of pentachlorophenol ("penta") dissolved in No. 2 fuel oil. The solution contained 10 percent toxicant, although 5 percent is now recommended.

Cold-soaking in penta is a simple, inexpensive method of protecting fence posts against decay. It was developed for farm use (see Illinois Agricultural Extension Circular 636). The effectiveness of the method depends upon several factors, one of which is length of soaking time. This report shows how soaking period has affected post durability.

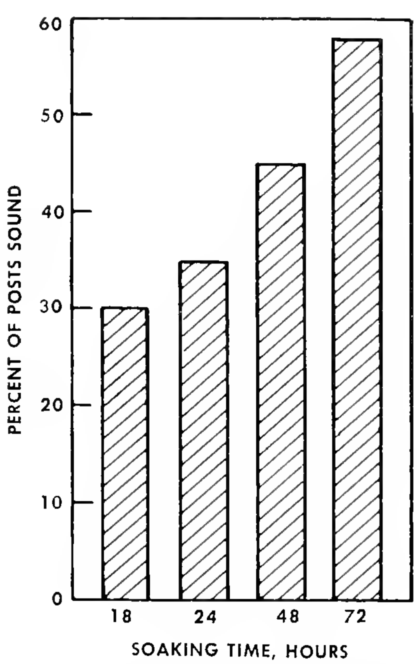
As shown in the table below, 183 (97 percent) of 190 posts were still serviceable after 21 years. The untreated controls lasted about 6 years. Although the table shows the condition of all the treated posts, the following analyses concern only the 81 posts that showed no decay.

Decay resistance

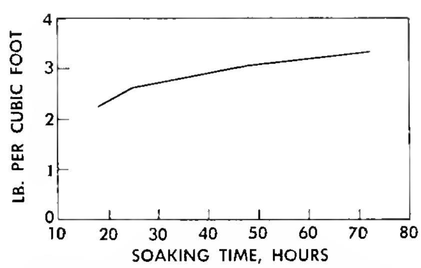
As shown in the table and in Figure 1, an increase in soaking time improved decay resistance. The percentage of posts remaining sound increased from 30 for the 18-hour soak to 58 for the 72-hour soak.

Absorption data (Fig. 2) and measurements of chemical penetration indicate that the sapwood was treated in 48 hours but that heartwood penetration was extremely shallow even after 72 hours. The relationship between soaking time and percentage of sound posts should level off after the solution reaches the heartwood.

One may conclude from these data that eastern white pine posts must be soaked at least 48 hours to be satisfactorily protected against decay.



Percent of posts still sound after 21 years' service, in relation to length of soaking time. (Fig. 1)



Amount of solution (pounds per cubic foot) absorbed by posts, in relation to length of soaking time. (Fig. 2)

Solution absorption

From the table and from Figure 2, we see that solution absorption increased from 2.24 ± 2.19 pounds per cubic foot (p.c.f.) to 3.35 ± 0.89 p.c.f. as soaking time increased from 18 to 72 hours. Absorption was greatest the first 6 hours, then the rate decreased over the next 24 hours, decreasing still further after 48 hours.

Posts soaked for 18 hours and 24 hours showed considerable variation in the amount of chemical absorbed. This is indicated by the size of the standard deviations (2.19 p.c.f. for the 18-hour period and 1.46 for the 24 hour period). In contrast, standard deviations for the 48- and 72-hour treatments are relatively low (0.87 p.c.f. and 0.89 p.c.f.), which indicates fairly uniform absorptions by the posts in these groups.

Judging from both the amount and uniformity of absorption, one may conclude that, here again, a 48-hour soaking period gives better results than shorter periods. Further field testing is necessary to determine whether it is worthwhile treating the posts 72 hours instead of 48 hours.

C. S. Walters is Professor of Wood Technology and Utilization.

Length of Soaking Time, Solution Absorption, and Condition of Eastern White Pine Fence Posts Following Exposure Tests

Soaking time, hours	Solution absorption, lb. cu. ft.	Condition: Sound	Condition: Partially decayed but serviceable	Condition: Failed	Condition: Total	Average service age of sound posts, years
18	2.24 ± 2.19	7 (30)[a]	15 (65)	1 (5)	23	21.0
24	2.61 ± 1.46	25 (35)	40 (56)	6 (9)	71	20.7
48	3.06 ± 0.87	24 (45)	29 (55)	0	53	20.7
72	3.35 ± 0.89	25 (58)	18 (42)	0	43	21.0
Total		81 (43)	102 (54)	7 (3)	190	

[a] Numbers in parentheses are percentages.

UDDER EDEMA: Its Incidence and Severity as Affected by Certain Management Practices

R. L. HAYS and J. L. ALBRIGHT

UDDER EDEMA — the swelling caused by too much fluid in the udder — is often a serious problem at calving time. The swollen udder is more prone to injury and mastitis than the normal udder. It also causes discomfort, is sometimes painful, and is often difficult to completely milk out. The milking machine has to be attached with special care to keep it from falling off the udder. If a cow has severe edema repeatedly, the udder becomes more and more pendulous, further increasing udder problems.

Udder edema begins as early as three weeks before calving and reaches a maximum near the time of calving. It starts in the floor of the rear quarters and is usually most severe in that area (Fig. 1). As the condition worsens, it may extend up to the body wall on the sides, the vulva in the rear, and the brisket in front (Fig. 2). Edema in front of the udder is common in heifers but unusual in cows.

Some of the excess fluid accumulates in the mammary tissue. Most of it, however, is trapped in the connective tissue just under the skin (Fig. 3) and cannot be drained by puncture. Since the teats are attached to the glanular tissue, they are frequently shortened as a result of the swelling under the skin (Fig. 3). This is one reason for the difficulty of milking these cows.

Udder edema has received little attention by research workers and veterinary texts. Probable reasons are that edema is difficult to measure; causes are unknown, as are the factors affecting incidence and severity; and there are no good, effective preventive and therapeutic measures.

The incidence of udder edema is not well known. In one survey of 12,000 cows, it was estimated that 18 percent had edema, but veterinarians were consulted for only 4.5 percent of the cows. The study reported here was made to determine the incidence and severity of edema and some of the factors affecting both incidence and severity.

R. L. Hays is Associate Professor of Physiology, Department of Dairy Science; and J. L. Albright was formerly Assistant Professor of Dairy Science. The authors wish to thank Roy Shirley for evaluating the amount of edema for this study.

How cows were rated

Cows in the study were from the University herd. They all calved at least once from 1961 through 1964. The number of cows of each breed and the total number of lactations are as follows:

Breed	*Number of cows*	*Number of lactations*
Holstein	144	244
Brown Swiss	41	84
Ayrshire	31	50
Jersey	29	52
Guernsey	19	26
Total	264	456

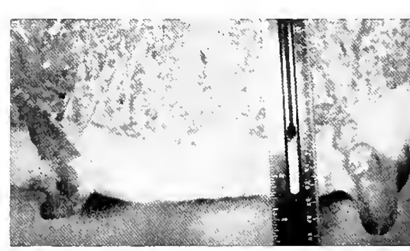
Cows were examined for edema on the day of calving and on the third, seventh, and thirtieth days after calving. Severity of edema was rated on a scale of 0-15. The same person, using palpation or touch, rated all the cows.

Nearly all the cows (96.4 percent) had detectable edema at the first calving, and most (81.5 percent) had some edema at later calvings. The incidence of severe edema is therefore more meaningful than that of detectable edema. For this study, somewhat arbitrarily, a rating of 9 or more was considered severe. Cows with this amount of edema usually received veterinary treatment and frequently had lasting effects such as scar tissue or pendulous udders.

Of 63 cows having a rating of 9 or higher, 22 (35 percent) were culled before they completed a 305-day lactation, and 14 others (22 percent) did not complete a second lactation. These cows were culled for a variety

A cow with edema. Note indentations in udder, made by applying pressure. (Fig. 1)

A heifer with edema that is especially prominent in the floor of the udder and in front of the udder. (Fig. 2)



Longitudinal section of edematous udder through the front end and rear teats. The white edematous layer between the skin and secretory tissue would be barely visible in a normal udder. (Fig. 3)

of reasons, but the most common ones were mastitis and poorly attached or pendulous udders. The culling rate for cows with serious edema was much higher than for those having less edema.

Number of lactations

It is generally recognized that severe edema is more likely to occur during a cow's first lactation than during later lactations. The data confirm this, showing, with successive lactations, a decrease both in the average ratings for severity of edema and in the percentage of cows having severe edema (Table 1). The decrease in both measures of edema was most pronounced between the first and second lactations, after which the decline became more gradual. Part of this decline is probably due to the higher culling rate in cows having severe edema. However, the decline is readily apparent in the cows for which we had records for three or four lactations.

Along with the trend for decreased edema with successive lactations, cows that have severe edema the first lactation apparently tend to have considerable edema in the next lactation, while those which have little or no edema at first are likely to have very little in later lactations.

Table 1. — Average Ratings for Degree of Edema and Percentages of Cows Having Severe Edema, by Lactation[a]

Lactation number	Holsteins, Guernseys: Aver. rating	Holsteins, Guernseys: Pct. severe	Ayrshires, Brown Swiss, Jerseys: Aver. rating	Ayrshires, Brown Swiss, Jerseys: Pct. severe
1	6.9	37.5	4.9	15.6
2	4.5	19.4	2.4	4.0
3	4.2	16.7	2.3	6.5
4	3.6	18.2	1.5	0
5+	2.5	6.9	.8	0

[a] Rating was on a 0-15 scale, with a rating of 9 or above considered severe.

Breed

Because of the small number of cows, it was deemed best to combine certain breeds when evaluating data. Since the Ayrshires, Brown Swiss, and Jerseys did not seem to differ in average rating or in incidence of severity, they were considered together. For similar reasons, the Holsteins and Guernseys were put into one group.

The Holstein-Guernsey group had a higher average rating and a higher incidence of severity in each lactation (Table 1). The incidence of hard fibrous tissue remaining in the floor of the udder beyond 30 days in the Holstein-Guernsey group was over five times that of the other group (8.2 percent vs. 1.6 percent).

Table 2. — The Relationship of Age at First Calving to the Incidence of Severe Edema

Breed and severity of edema	Age, months: 23–26	27–28	29–37
Holsteins, Guernseys			
Total number	34	45	25
Number severe	6	19	14
Pct. severe	17.6	44.4	56.0
Ayrshires, Brown Swiss			
Total number	8	25	13
Number severe	0	1	4
Pct. severe	0	4.0	30.8

Age at first calving

In general, the older a heifer at her first calving, the greater the probability of severe edema. This was especially true for Holsteins and Guernseys above 26 months and Ayrshires and Brown Swiss above 28 months (Table 2). Since Jerseys mature younger than the other breeds, they were considered separately. Among the small number of Jerseys in the herd, the age at first calving apparently did not affect edema.

Season

It was interesting to find more severe edema in the fall and winter than in the spring and summer. There is no apparent explanation for this difference. It seems unlikely that it was due to feeding, because the rations did not differ greatly during the year and the changes in incidence did not coincide with the pasture season. The amount of exercise does not seem to explain the difference, because the cows were confined for several days before calving regardless of season.

Dry period

The incidence of severe edema increased with the length of the dry period (Table 4). It was highest in the Holstein and Guernsey cows dry over 90 days. No cases of severe edema occurred in the Ayrshire, Brown Swiss, and Jersey cows dry less than 70 days.

Table 3. — Relationship of Season to Incidence of Severe Edema

Lactation number	March–August: No. of cows	No. severe	Pct. severe	September–February: No. of cows	No. severe	Pct. severe
Holsteins, Guernseys						
1	56	17	30.4	48	22	45.8
2+	83	8	9.6	83	19	22.9
Ayrshires, Brown Swiss, Jerseys						
1	28	2	7.1	36	8	22.2
2+	56	0	0	66	4	6.1

Table 4. — Relationship of Length of Preceding Dry Period to Incidence of Severe Edema

Breed and number of dry days	Number of cows	Number severe	Percent severe
Holsteins, Guernseys			
Less than 50 days	39	2	5.1
51–70 days	37	5	13.5
71–90 days	29	3	10.3
More than 90 days	60	17	28.3
Ayrshires, Brown Swiss, Jerseys			
Less than 50 days	25	0	0
51–70 days	36	0	0
71–90 days	19	1	5.3
More than 90 days	38	3	7.9

Control Those Weeds Early!

E. L. KNAKE and F. W. SLIFE

YOU DON'T NEED to be too concerned about weeds that pop out on the Fourth of July. The main culprits are the weeds which begin growing as soon as the crop does. So concentrate on weed control early. If the crop is given a head start on the weeds, it will soon cast enough shade to help keep the late-starting weeds under control.

Giant foxtail studied

The value of early weed control has been confirmed by a three-year study at the Agronomy South Farm at Urbana. Corn and soybeans were seeded during the first half of May each year. Giant foxtail was then seeded at different times in the row with the crop. The spaces between the rows were cultivated and kept free of weeds.

On some plots foxtail was seeded the same day as the crop. Other plots were kept weed-free for 3, 6, 9, or 12 weeks before seeding the foxtail. One series of plots was kept weed-free all season.

Where foxtail began growing at the same time as the crop and was left to maturity, both corn and soybean yields were seriously reduced. Corn yields were reduced by 17 bushels per acre, or 13 percent (Fig. 3); soybean yields, by 10 bushels, or 27 percent (Fig. 4). Yields were not significantly reduced by foxtail that was seeded 3 weeks or more after the crop was planted.

Foxtail that began growing at the same time as soybeans kept pace with the crop quite well. By actually growing above the beans, the foxtail received more sunlight and grew better than foxtail that had been seeded the same time as corn. Consequently the early foxtail produced more dry matter per acre in soybeans than in corn and reduced bean yields more than corn yields.

The late-starting weeds, however, received more shade and more competition from the soybeans than from the corn. In fact, after 3 to 5 weeks the shade under soybeans became so dense that foxtail usually could not survive.

In corn, where shade was less dense than under beans, late-starting foxtail made more growth. When foxtail was seeded 3 weeks after corn, it produced 500 pounds of dry matter per acre. But by this time corn apparently had its root system well established and had the competitive advantage over the weeds, so that corn yields were not significantly reduced.

Although the late foxtail did not reduce corn yields, it did produce seed which could germinate in later years. Even plants seeded at the end of July produced seed although the weeds grew only about 6 inches high.

The corn population was 15,700 plants per acre. Other research at Urbana suggests that a higher population, providing more shade, might further reduce foxtail growth. Soil type, soil fertility, and hybrid should be major considerations when deciding on corn population. But the advantage of better weed control from higher populations should not be overlooked.

Giant foxtail was used for our research because it is considered the most serious annual weed in Illinois. We have not conducted time-of-seeding research with other species. Some weeds are more tolerant of shade than giant foxtail and might be affected differently. Competitive relationships might also vary with different species. In general, however, we believe that the most serious weeds are those which begin growing with the crop. This conclusion is supported by research at other stations.

Four aces you can play

As we have seen, the first 3 to 5 weeks after the crop is planted are critical for weed control. If you can control weeds then, the crop will be able to compete quite well with later weeds. Fortunately, you have four aces to play against these early weeds — preemergence herbicides, cultivation with the rotary hoe, row cultivations, and postemergence applications of 2,4-D.

Preemergence herbicides are especially helpful for controlling weeds that grow directly in the crop row. Weeds in the row have become more of a problem now that practically all of the corn in Illinois is either hill-dropped or drilled, making cross-cultivation impossible. Many farmers have consequently turned to preemergence herbicides for help.

These herbicides are usually applied in a 12- to 14-inch band over the row as the crop is planted. They were used on about a third of the corn and soybean acreage in Illinois in 1965.

Preemergence herbicides have been very helpful where other practices were not giving adequate control. They should not, however, be used indiscriminately.

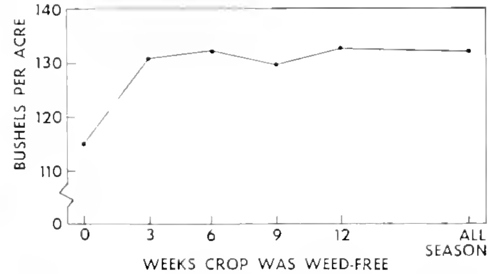
The rotary hoe is an excellent tool for controlling weeds early. According to a recent survey by the Illinois Crop Reporting Service, the rotary hoe is being used on 62 percent of the corn acreage and 76 percent of the soybean acreage. It can be used shortly after the weed seeds germinate — even before the weeds are showing above the soil surface.

If a preemergence herbicide has been used and is controlling weeds effectively, there is usually no need for rushing in with the rotary hoe. However, when weather is dry for about 2 weeks and it appears that the herbicide may not be effective, it's best to move in with cultivation

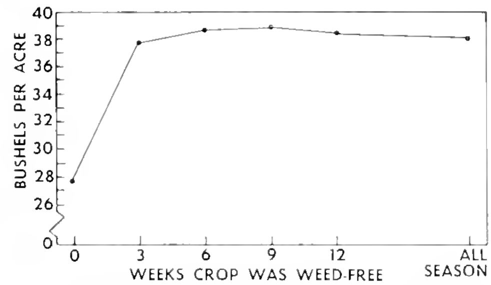
E. L. Knake is Associate Professor of Weed Extension; F. W. Slife is Professor of Crop Production and Associate Head of the Department of Agronomy.

Where giant foxtail was seeded the same time as the corn, it grew vigorously and reduced crop yields by 17 bushels per acre or 13 percent. (Fig. 1)

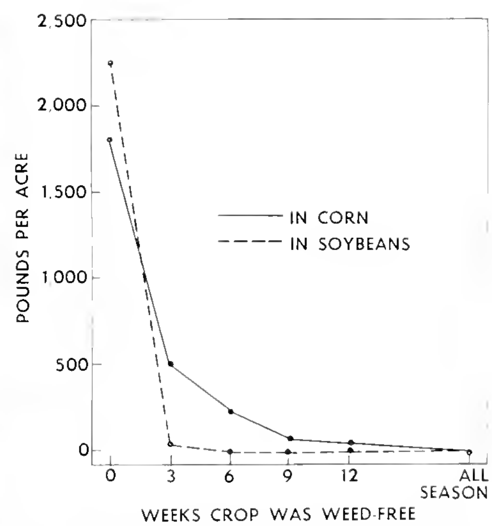
Where foxtail was seeded 6 weeks after the corn, it did not compete with the crop. In fact, yields were not seriously reduced if the corn was given a head start of even 3 weeks. (Fig. 2)



Corn yields as affected by the number of weeks that the crop was weed-free. (Fig. 3)



Soybean yields as affected by the number of weeks that the crop was weed-free. (Fig. 4)



Pounds of dry matter per acre produced by foxtail, as affected by number of weeks that corn and soybeans were weed-free. (Fig. 5)

equipment before weeds become well established.

When used 2 weeks after application of a preemergence herbicide, the rotary hoe usually has had no detrimental effect on the herbicide, but rather has improved weed control.

Timely row cultivation to throw soil into the row and smother weeds when small is still one of the most effective methods of weed control. Preemergence herbicides can increase the speed and ease of cultivation, but they only supplement good cultivation; they do not take its place. According to a recent survey, Illinois farmers, on the average, were cultivating corn and soybeans twice.

Postemergence applications of 2, 4-D in corn, after the weeds are up, is one of the most effective and economical controls for many broadleaved weeds. For best results it should be applied early when weeds are small and easiest to control and before they have competed seriously with the crop.

Play these aces against weeds early in the game and you'll be well on your way to winning.

EFFECTS OF WEAR ON NOZZLE TIPS

How output and spray distribution pattern are altered after banding different amounts of preemergence herbicide

J. D. DOLL, E. L. KNAKE, and B. J. BUTLER

As more and more farmers strive to grow 150 bushels of corn per acre, an effective weed-control program becomes increasingly important to them. Many farmers have found that preemergence sprays are one of their best weapons against weeds.

One problem that arises from the continued use of sprays is their effect on spray equipment. Nozzle tips and pumps are especially likely to be abraded by the wettable powders and solutions used in spraying. As a result, the spray volume and distribution pattern change, possibly causing crop damage, residue problems, and increased application costs.

Used nozzle tips studied

A recent study in the Departments of Agronomy and Agricultural Engineering was designed to learn when nozzle tips should be changed because of variations in spray volume or distribution pattern.

Used nozzle tips were obtained from a number of farms, most of them in east-central Illinois. The farm operators provided information on the number of acres sprayed, herbicide used, planting speed, and pressure.

Eight sets of 8003-E brass nozzle tips were selected for study. All the tips had been used for band spraying. Length of use varied from 1 to 7 years. The operators had used pressures ranging from 24 to 40 p.s.i. and had applied 7 to 10 gallons of mixture per crop acre.

How nozzles were tested

The eight sets of used nozzle tips were tested in the laboratory along with 20 new tips. Pure tap water was used in a spraying device operated at 30 p.s.i. To determine the volume sprayed, the water was collected in beakers, measured, and recorded as milliliters per minute.

Spray distribution patterns were determined by spraying a 14-inch band of water onto a gently sloping galvanized steel tray which was divided into 1-inch compartments. When the water flow from the tray reached a constant rate, a rack with fourteen 80-milliliter test tubes was placed under the tray for 30 seconds to collect the water from the 1-inch sections. The volume collected from each section was recorded.

Results for the four nozzles in each used set were averaged to obtain the output and spray distribution for one nozzle.

Output of nozzles

The output of the new nozzles was quite consistent, ranging from 964 to 1,002 milliliters per minute. This is less than 4 percent variation and may have been partly due to sampling error.

Output of the used nozzles was compared with the average output of the new ones. As shown in the table on page 11, output per nozzle increased with amount of previous use. The increase in output was as much as 36 percent for a nozzle tip that had been used for applying 5,200 gallons of spray to 650 acres. Since the table is based on the output of one nozzle tip, this would mean that the farmer, using a four-row planter, actually planted 2,600 acres of corn.

Previous research has emphasized that the abrasive action of wettable powders increases the orifice size of the nozzle tip. The data in the table indicate that spraying with a liquid herbicide also enlarges the nozzle orifice.

In general, output increased at a greater rate when the nozzle tips were first used than after they had received some wear. This is indicated by the percent increase in output for each 100 gallons of spray that had been applied on the farm. For example, a tip used for only 250 gallons had an increased output of 5.56 percent per 100 gallons; while a tip that had been used for 5,200 gallons had an increased output of only 0.68 percent per 100 gallons.

Spray distribution pattern

As shown in Figures 1 and 2, even the new nozzle tips had an uneven distribution pattern. More spray was directed toward the edges of the pattern than might be expected. This may not be objectionable if there is some dissipation or lateral movement of the herbicide from the edges of the band to the adjacent untreated areas.

Use of liquid and of wettable-powder herbicides caused similar alterations in the distribution pattern (Figs. 1 and 2). There was little pattern change for the first 53 acres sprayed with liquid herbicide (Fig. 1). After 116 acres had been sprayed, however, the output defi-

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J. D. Doll was formerly Assistant in Agronomy; E. L. Knake is Associate Professor of Weed Extension; and B. J. Butler is Associate Professor of Agricultural Engineering.

nitely increased at the edges of the band and became more variable at the center. After 652 acres had been sprayed, the pattern was highly irregular, with high concentrations at the edges and the center of the band. Output near the center was nearly double that of a new nozzle tip. Since this concentration would be almost directly over the planted seed, it could injure the crop if the crop had a low degree of tolerance to the herbicide.

Spraying 88 acres with a wettable-powder herbicide increased output slightly more at the edges of the band than in the center (Fig. 2). Spraying 114 acres caused more increase at the center of the band, but the general pattern followed that of the new nozzle tips. After 250 acres were sprayed, the peaks at the edges and in the center resembled the pattern after 652 acres had been sprayed with a liquid herbicide (Fig. 1).

History of Past Use of Nozzle Tips and Percent Increase in Output Resulting From Past Use

Herbicide	Past history: Acres band-sprayed per nozzle tip	Past history: Gal. of spray per nozzle tip	Percent increase in output: Total	Percent increase in output: Per 100 gal. of past use
Liquid solutions				
CDAA (Randox)	28	252	14.0	5.56
CDAA (Randox)	53[a]	423	16.0	3.78
CDAA (Randox)	116	1,160	25.2	2.17
CDAA (Randox)	652	5,216	35.6	0.68
Wettable powders				
⅔ atrazine, ⅓ linuron (Lorox)	88	704	7.8	1.11
Atrazine	114	1,140	22.6	1.98
Atrazine	250	1,750	27.5	1.57

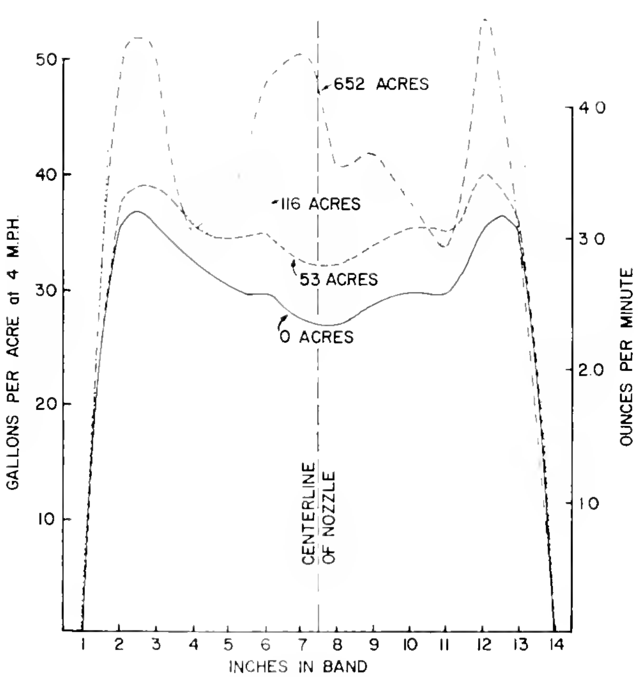
[a] Average for two sets of nozzle tips used for 50 and 55 acres.

Regulating output and pattern

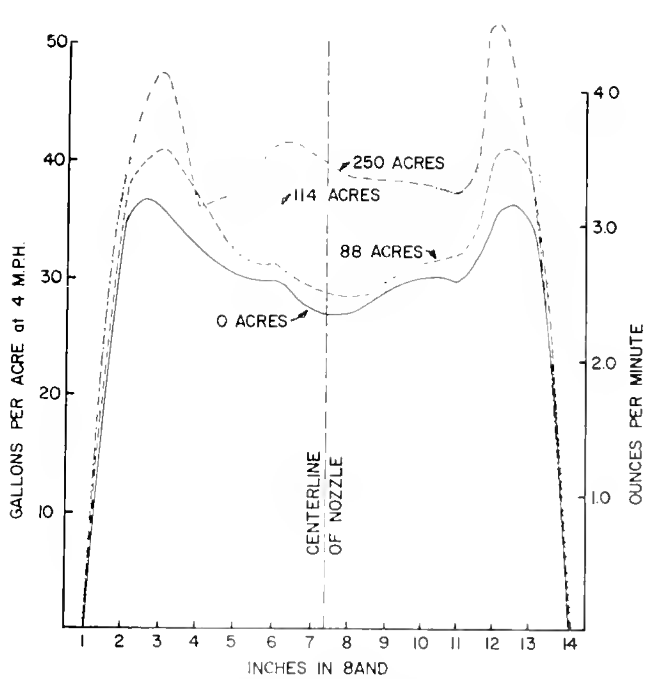
Since the output from brass nozzle tips increases very rapidly, periodic calibration of spray equipment is essential. According to both this and other studies, output can increase as much as 10 percent after 250 gallons of spray have passed through a nozzle tip. With a band application of 10 gallons of spray per acre and four nozzles behind a planter, this 10-percent increase could develop after a total of 100 acres have been sprayed. This suggests that daily calibration is desirable and that operating pressures should be gradually lowered until nozzle tips are replaced.

Nozzle tips have to be replaced periodically because of the changes in distribution caused by wear. On the basis of this study, we suggest that brass nozzle tips be replaced after each tip has been used for about 100 acres, or after 400 acres have been planted using four nozzles behind a four-row planter. Although stainless steel tips cost more than the brass tips (about $1.50 as compared with 50 cents), they are more resistant to wear and would not need replacing as often.

Since nozzle tips are mass-produced, low-cost items, it is somewhat surprising that they are as accurate as they are. The new brass nozzle tips used in this study had a quite consistent output and a satisfactory distribution pattern.



Distribution pattern of spray from brass nozzle tips before use and after band-spraying a liquid herbicide on 53, 116, and 652 acres. (Fig. 1)



Distribution pattern of spray from brass nozzle tips before use and after band-spraying a wettable powder herbicide on 88, 114, and 250 acres. (Fig. 2)

Microbial Content of Four FROZEN MEAT PRODUCTS

JOANNE K. BRYNJOLFSSON and FRANCES O. VAN DUYNE

Joanne K. Brynjolfsson, former Assistant in Home Economics, is making a bacterial count on a food sample. Co-author Frances O. Van Duyne is Professor of Foods. This article is based on work that Mrs. Brynjolfsson did for her master's degree under Dr. Van Duyne's direction.

Frozen foods are not generally suspected of being health hazards. Questions have been raised, however, concerning the potential danger of mishandling these foods. Freezing decreases the microbial population of a food product, but it is by no means a cold-sterilization process. Disease-producing and other microorganisms can survive for many months at subzero temperatures. Whether or not harmful bacteria are present when a food is eaten depends upon the numbers and kinds originally present and the treatment before and after freezer storage.

In the experiments described here we investigated the bacterial content of four commercially frozen meat products. Tests were made both before and after the products were prepared for serving.

Frozen beef chop suey, beef stew, breaded pork patties, and chicken livers were the products investigated. The first three were selected largely because they were precooked. According to previous work, the ingredients of precooked foods may be excellent substrates for bacterial growth. In addition, cooking may alter the structure of the foods, making them more susceptible to microbial attack. A further reason for choosing the pork patties was that breading and battering have been shown to greatly increase the bacterial load.

The chicken livers were not precooked. Livers and giblets, however, are exposed to possible sources of contamination while chicken carcasses are being processed, and so may become highly contaminated.

Procedures

All the frozen foods were purchased from local retail markets as needed throughout the study. To simulate the treatment given to commercial frozen products by consumers, there was a "carry home" period of no longer than one-half hour. The packages were then stored at -1° C. in the freezer compartment of a home-type refrigerator until used. Storage periods in the freezer compartment never exceeded 2 weeks.

Each type of frozen product was purchased four times, and was sampled both in the frozen, "as purchased," form and in the cooked or reheated form. The three precooked products were reheated and the chicken livers were cooked according to the directions on the package.

Except for frozen beef stew, "as purchased" and reheated or cooked samples were taken from the same package. The stew was packaged in a "boilable" bag and would not be opened before reheating for serving.

Microbiological analyses were carried out according to techniques described in *Recommended Methods for the Microbiological Examination of Foods*. Plate counts were made of the total bacteria in the foods, and also of the enterococci, staphylococci, and coliforms present. Total plate counts were made on tryptone glucose yeast extract agar, and plate counts of enterococci were made on KF streptococcus medium.

Staphylococcus medium 110 was used as the solid selective medium for enumerating staphylococci. Any pigmented colonies of these organisms were tested to see if they were coagulase-positive and hence potential food-poisoning organisms.

Violet red bile agar was used to determine total coliform organisms. Representative coliform colonies were then transferred to "dry" Levine eosin methylene blue agar plates to determine the percentage of *Escherichia coli* organisms, and brilliant green bile 2 percent was used in the presumptive test for members of the coliform group.

A taste panel evaluated the reheated or cooked products on appearance, color, texture, and flavor. Each characteristic was rated on a five-point basis, and individual scores for each characteristic were added to obtain a total score for a product.

Numbers of microorganisms

Of the "as purchased" frozen samples, beef stew had the lowest mean total plate count — 19,500 organisms per gram of sample. The breaded pork patties had the highest — 399,300 organisms per gram. Mean count for beef chop suey was 36,300; and for the chicken livers, 183,400.

Two of these mean counts are in excess of a proposed standard of 100,000 organisms per gram of sample. Many investigators think that this standard is reasonable and can be complied with if processing conditions are hygienic. However, the assumption that low total counts indicate safety has been shown to be not always true.

Coliforms were not found in the samples of beef chop suey or beef stew examined. The chicken livers and breaded pork patties had mean

total coliform counts of 54 and 80 organisms per gram, respectively. Almost half of the coliform organisms were determined as *Escherichia coli*. Seven of the eight samples of chicken livers and breaded pork patties produced growth. In six samples the growth exceeded a proposed coliform standard of 10 microorganisms per gram.

Since the coliform organisms exist in association with other microorganisms in the intestine, the coliforms are widely used as indicators of fecal contamination of water and dairy products. Problems arise, though, when this index is transferred to other foods. Except for *Escherichia coli* (which occur in vegetables from heavily manured soils or in animal products such as eggs, poultry, or meat), the coliforms and enterococci are widely distributed. Their presence alone, therefore, is not conclusive evidence of contamination.

Isolation of fecal-indicator organisms justifies investigating the source of the organisms or their means of entry into the food. The food should not be condemned, however, unless it is shown that the organisms indicate filth, unsanitary practices, or a potential hazard.

Mean enterococci counts ranged from 31 for the frozen beef stew to 1,900 for the breaded pork patties. The beef chop suey had a mean enterococci count of 1,200; and the chicken livers, one of 600 organisms per gram. The highest individual enterococci count, 5,600, was obtained from a pork patty sample.

Various laboratories have shown remarkable agreement in finding that many more enterococci than coliforms persist in frozen foods. It thus seems that enterococcus indexes in combination with total counts may have distinct advantages over a coliform index in evaluating the sanitary history of frozen foods before freezing.

Staphylococci organisms were found in every "as purchased" frozen meat product examined. Pigmented colonies which were tested and found to be coagulase-positive were isolated from only two samples of raw frozen chicken livers. The coagulase-positive staphylococci averaged 1,100 organisms per gram in one sample and 12,200 in the other. These numbers could be of food poisoning significance if the products were not properly stored or cooked.

As was expected, the total plate counts were decreased markedly by reheating or cooking. Neither the coliform organisms nor the enterococci survived the preparation for serving. Small numbers of staphylococci survived cooking or reheating in over one-half the frozen samples, but none of the surviving organisms were coagulase-positive staphylococci.

Palatability

The total mean score for breaded pork patties indicated that the judges considered these products to be of lower quality than the others. Out of a possible total mean score of 20, the score for the patties was 14.8 ± 0.28, which corresponded to a rating between fair and good. Some of the samples had a slightly rancid flavor.

The beef stew and beef chop suey had total mean scores of 17.6 ± 0.36 and 17.7 ± 0.28, respectively. The chicken livers received the highest scores for all samples, and the total mean score was 19.0 ± 0.19.

Thorough cooking essential

As shown in this study, potentially dangerous microorganisms may be present in some frozen foods when you bring them home from the store. Relatively few microorganisms survived cooking or reheating, however, and those that did survive were not a health hazard. The data obtained in this study emphasize the importance of thorough cooking and strict adherence to storage and cooking directions.

Numbers of Microorganisms per Gram of Frozen Food Samples, "As Purchased" and After Cooking or Reheating[a]

Organism	Beef chop suey		Beef stew		Chicken livers		Pork patties	
	As purchased	Reheated	As purchased	Reheated	As purchased	Cooked	As purchased	Reheated
Total plate count								
Range in no.	2,100–111,000	200–400	2,700–31,000	20–600	30,000–406,000	n.g.[b]–400	66,700–617,300	3–70
Mean no.	36,300	300	19,500	300	183,400	100	399,300	38
Total coliforms								
Range in no.	n.g.	n.g.	n.g.	n.g.	7–96	n.g.	n.g.–200	n.g.
Mean no.					54		80	
E. coli								
Range in no.	n.g.	n.g.	n.g.	n.g.	3–40	n.g.	n.g.–100	n.g.
Mean no.					28		39	
Enterococci								
Range in no.	200–3,200	n.g.	n.g.–56	n.g.	200–900	n.g.	200–5,600	n.g.
Mean no.	1,200		31		600		1,900	
Staphylococci								
Nonpigmented								
Range in no.	100–300	n.g.–100	67–5,200	n.g.–200	1,400–11,700	n.g.–30	700–2,400	33–67
Mean no.	200	67	1,500	50	5,300	8	1,500	42
Pigmented[c]								
Range in no.	n.g.	n.g.	n.g.	n.g.	n.g.–12,200	n.g.	n.g.	n.g.
Mean no.					3,300			

[a] Each number represents an average of triplicate plate counts averaged for every dilution showing the proper range of growth. All counts were rounded off to the nearest 100 with the exception of counts below 100, which were left as recorded.

[b] n.g. = no growth.

[c] Numbers of organisms which were pigmented and coagulase-positive

Variations in Fertilizer Expenditures in Illinois

R. J. MUTTI

How much do farms vary in the amount spent for fertilizers? And how much does the amount spent on fertilizer affect returns? These were two of the questions that prompted a recent study of farm account records for 1963. A random sample of records was selected from four areas in the state. In each area a specific soil association representative of a larger area was dominant.

As shown in the table, expenditures for fertilizer averaged highest in the east-central and south-central areas. These areas had higher percentages of land in corn, soybeans, and wheat than the other two areas, and much smaller amounts of livestock manure available (assumed from amount of feed fed to livestock). The east-central area had the highest soil productivity rating, while the south-central area had the lowest rating.

Farms within each area varied widely in expenditures for fertilizer. Only 1 percent of the farmers bought no fertilizer, and these were all in the northern and western areas.

By means of a multiple regression analysis, the relationship of crop returns per tillable acre to four other variables was determined. These variables were soil productivity rating; percent of land in corn, soybeans, and wheat; fertilizer expenditures per tillable acre; and value of feed fed per tillable acre.

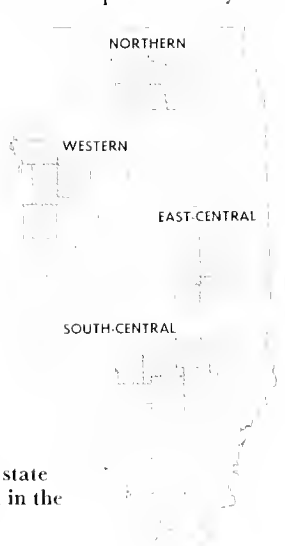
The four variables explained 53 percent of the variation in crop returns in western Illinois; 54 percent in south-central Illinois; 55 percent in northern Illinois; and 59 percent in east-central Illinois. The rest of the variation (41 to 47 percent) has to be explained by variables not included in the account summary sheets (such as weather and management practices).

In all four areas the percentage of land in corn, wheat, and soybeans explained more of the variation in crop returns than any other variable tested. Expenditures for fertilizer ranked second in all areas except the northern one, where value of feed fed was slightly more important. Fertilizer expenditures explained more of the variation in crop returns in east-central Illinois than in the other areas. In all areas the soil productivity rating explained only a small part of the variation. This was due to the predominance of a given soil association in each area.

Expenditures for fertilizer gave the greatest returns in the south-central area. There every dollar spent for fertilizer increased crop returns by $1.43. The least return from each dollar's worth of fertilizer was $1.03 in the western area. In the northern area the return was $1.23; in the east-central area, $1.21.

The results reported here cover only one year and do not include analyses of several highly important determinants of crop yields. Other research workers are studying these determinants, so more information can be expected on the reasons for differences in crop yields due to fertilizer use.

R. J. Mutti is Professor of Agricultural Marketing. The author thanks V. I. West and A. G. Mueller for their helpful suggestions.



Areas of state included in the study.

Amounts Spent for Soil Fertility and Averages for Other Variables

Variable	Area: Northern	Western	East-central	South-central
Soil fertility cost per tillable acre	*Percent of farms*			
Less than $4.00	35.7	17.6	6.2	11.6
$ 4.00– 7.99	35.6	37.2	37.2	33.2
8.00–11.99	17.9	29.4	32.6	34.6
12.00–15.99	9.0	11.8	18.6	10.3
16.00 or over	1.8	4.0	5.4	10.3
Median expenditure	$5.46	$7.65	$8.60	$8.13
Mean expenditure	6.28	7.98	9.35	9.20
Standard deviation from mean	3.85	4.23	4.32	5.05
Range	0–18.02	0–22.69	2.20–28.91	.17–27.20
Soil productivity rating[a]	78.5	75.5	86.5	27.7
Percent of tillable acres in corn, soybeans and wheat[b]	58.2	64.1	83.5	77.5
Value of feed fed per tillable acre[c]	$81.03	$76.52	$18.56	$42.76
Crop returns per tillable acre[d]	$85.91	$84.09	$104.04	$71.49

[a] Two-thirds of the records in the northern and western areas fell within 12 percent of the area averages; in the east-central area, within 7 percent; in the south-central area, within 18 percent.
[b] Two-thirds of the farms fell within these percentages of the area averages: 25 percent, northern area; 21 percent, western; 11 percent, east-central; and 22 percent, south-central. The last two areas include farms whose income comes mostly from the sale of grain.
[c] Two-thirds of the farms fell within these percentages of the area averages: 65 percent, northern and western areas; 151 percent, east-central; 99 percent, south-central. The high variability means that some farms fed little or no livestock, while others fed far more than the average.
[d] Two-thirds of the farms fell within these percentages of the area averages: 18 percent, northern and western areas; 13 percent, east-central; 26 percent, south-central.

A New Look at Synthetic Mulches

J. S. VANDEMARK, H. J. HOPEN, and J. W. COURTER

FOR SEVERAL YEARS growers of high-value crops have been using polyethylene instead of organic mulches on a limited scale. Experiments have also been conducted with paper as a mulching material (*Illinois Research*, Winter, 1960).

Unlike organic mulching materials, polyethylene increases soil temperatures. This permits northern growers to market part of their crops early in the season. Polyethylene also provides a vapor barrier for fumigation. A disadvantage of this material is that it must be removed by hand.

Paper mulch conserves moisture as well as polyethylene, but does not increase soil temperatures as much. Since paper decomposes, the removal problem is minimized. Some paper mulches decompose too soon, however, which limits their usefulness.

Papers designed specifically for mulching have recently become available. Features include extensibility (papers are finely creped), good wet strength, modified color, and the incorporation of fungicides into the papers. Length of serviceable life can also be varied, permitting selection of papers for specific growing conditions and crops.

Some papers may be polyethylene-laminated. A thin (¼ mil) layer of either black or clear polyethylene on one side of the paper increases soil temperature without causing a removal problem.

Different mulches observed

In 1965 we set up observational plots at four Illinois locations: Dixon Springs Agricultural Center, Simpson; Oquawka Sand Farm, Oquawka; Drug and Horticulture Experiment Station, Downers Grove; and the farm of Mr. Cliff Losch in Madison County. Several types of mulches were tried at each location.

Moisture distribution was ideal at Dixon Springs, so mulch was essentially of no value. At Oquawka, however, moisture distribution was extremely critical in May and June. The Oquawka soil had a low water-holding capacity, and the control plots produced little or no yields. This situation gave an excellent opportunity to study different mulching materials under extreme stress.

At Oquawka and Downers Grove, Table Queen squash and Cheyenne Bush pumpkin grew faster on all the mulched plots than on bare soil. Black Kraft paper, black polyethylene, and polyethylene-laminated paper increased vine growth more than brown Kraft paper. Clear polyethylene-laminated paper promoted more vine growth than black polyethylene-laminated paper.

The accelerated vine growth was reflected in increased yields. Selected experimental Kraft papers and polyethylene-laminated papers gave yields that were equal or superior to those on black polyethylene.

Harvest Queen cantaloupe was also grown at Oquawka. Again mulching increased vine growth. Yields were four to nine times as great on the mulched plots as on the unmulched plots. Mulching had little influence on melon size.

Mulching and fumigation

Two replicated experiments were run on cantaloupe in 1965 to show the effects of mulching and soil fumigation. The experiments were conducted on the Oquawka field and on the Losch farm. Clear polyethylene of 1½ mil thickness was chosen for mulching. Trizone, at the rate of 200 pounds per acre, was the fumigant.

On the Losch farm, we evaluated only two systems: (1) fumigated and mulched, and (2) bare soil or normal cultivation methods. A soil assay showed no parasitic nematodes in either the treated or the control areas. The value of fumigation here was in weed control. Plots were 400 feet long. Treated plots gave an early harvest of 289 fruits and a total harvest of 348. Yields on untreated plots were 181 fruits (early yield) and 202 fruits (total). The differences between the treated and the untreated plots are significant at the 1-percent level.

The Oquawka study included a set of plots which were fumigated but not mulched, making it possible to evaluate the importance of fumigation alone as well as fumigation plus mulching. Plots were 80 feet long with 6 feet between rows.

After fumigation on May 6, the variety Harvest Queen was seeded on May 17. A soil assay on June 6 showed parasitic nematodes on the control plots but not in the treated areas. Yields are shown below:

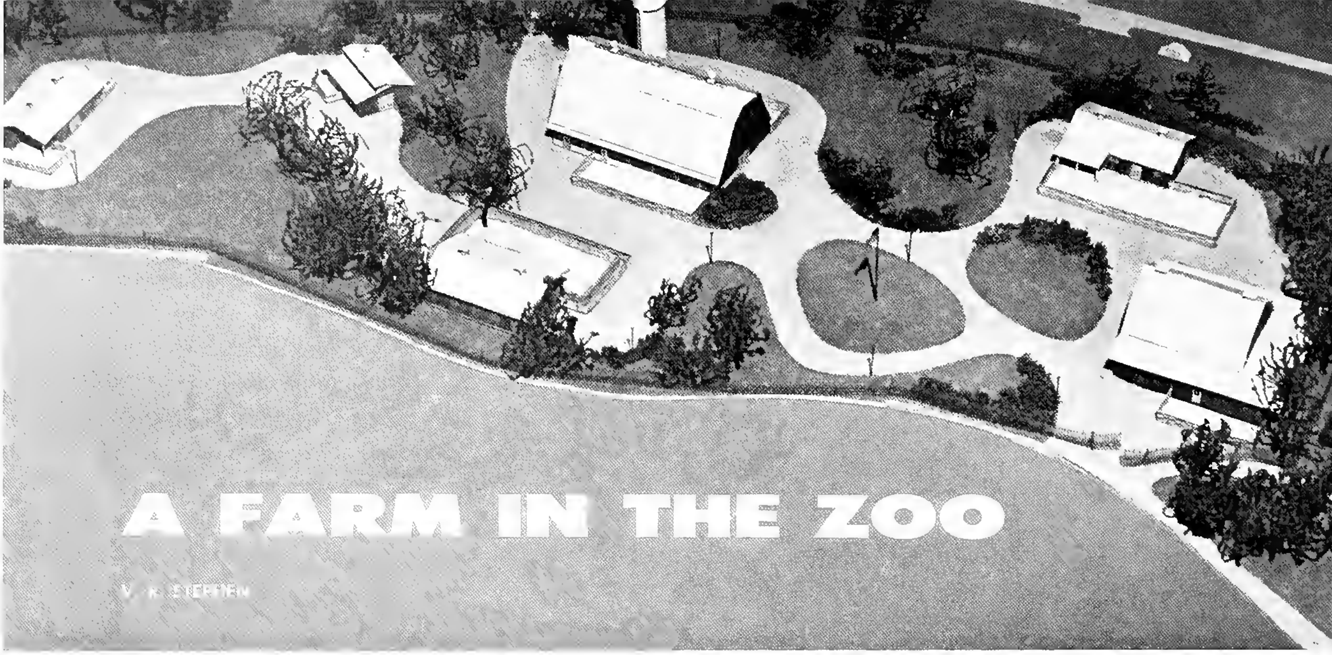
	No. of melons	*Wt. of melons*	*Av. wt.*
Fumigated, mulched	85	335*	4.3
Fumigated, no mulch	53	195*	3.8
Control	12*	32*	3.1

(*Significantly different at the 1-percent level.)

Mulched, fumigated plots produced cantaloupe at a rate of 631 bushels per acre, indicating the potential value of the new mulching materials.

Cantaloupe grown with fumigation and mulching (left) and on bare soil (right).

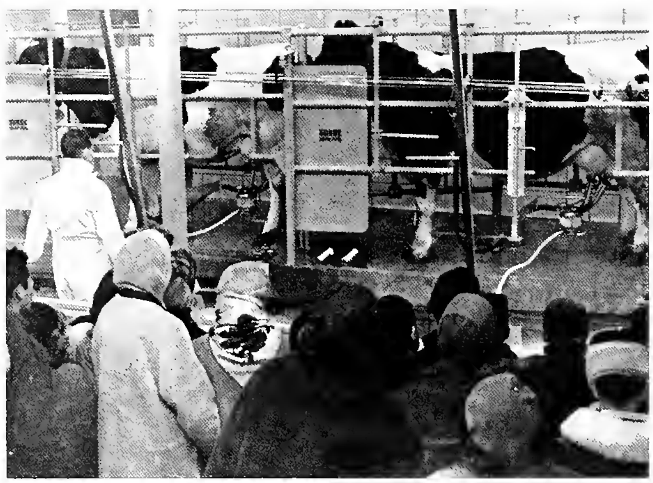
J. S. Vandemark is Professor of Horticulture; H. J. Hopen, Assistant Professor of Vegetable Crops; and J. W. Courter, Assistant Professor of Horticulture.



A FARM IN THE ZOO

V. R. STEPHEN

A NEW ATTRACTION at Lincoln Park Zoo has been designed for Chicago children — and adults, too — who may know more about lions and tigers than cows, sheep, and pigs. This is the "Farm-in-the-Zoo," conceived by the Lincoln Park Zoological Society and Zoo Director Lester Fisher, and developed with the aid of the Cooperative Extension Service, as well as other organizations. The purpose of the project is not just to acquaint city dwellers with farm animals, but also to show them how foods and fibers are produced and marketed.



ABOVE: Model shows how the Farm-in-the-Zoo will look when it is completed. The buildings (left to right) are: sheep and swine barn, poultry house, horse barn, main barn (with silo), beef cattle barn, and dairy barn. The sheep and swine barn and poultry house are still to be built.

AT LEFT: Milking time draws many interested spectators.

The Farm-in-the-Zoo is a 5-acre tract of rural Illinois, surrounded by high-rising apartment buildings and city traffic. So far four attractive red and white buildings have been completed. A main barn and a dairy barn were opened to the public in December, 1964. Beef cattle and horse barns were finished in November, 1965. A poultry building and a combined sheep and swine barn are planned for future construction. The park department is landscaping the area to enhance the appearance of the barns and provide shady lanes with a rural atmosphere.

Until all the buildings are completed, sheep, swine, and poultry are being displayed in the main barn. Breeds of all classes of livestock are changed regularly so people can become acquainted with the different ones. At 10 a.m., noon, and 2 p.m., zoo visitors can watch cows being milked in the glassed-in milking parlor at the dairy barn.

The exhibition area in the main barn features educational displays on agricultural and related subjects. At present, large displays are changed every four to six months, while smaller special displays are replaced more often. Agricultural organizations and related industries are invited to provide exhibits, with the requirement that the exhibits be educational rather than promotional.

The Cooperative Extension Service is aiding the project in several ways. Extension specialists provide needed technical information, including advice on the selection, display, and care of the animals. Extension also helps to schedule displays in the main barn, as well as designing and constructing several exhibits each year. One exhibit consists of eight large photographs with a question under each. The visitor may choose between three possible answers by pressing a button, thus testing his knowledge of Illinois agriculture.

The Extension Editorial Office is serving as liaison between the Zoo administration and the Cooperative Extension Service. It is also providing news coverage through its press, radio, and television services.

If you live in Chicago, or go there as a visitor, why not take your family to see this unique Farm-in-the-Zoo?

V. R. Stephen is Assistant Extension Editor with rank of Assistant Professor.

RESEARCH IN BRIEF

Three Parasite Species That Cause Coccidiosis in Dogs Are Identified

Dogs, especially young puppies, are frequently affected by a disease called coccidiosis. It causes a severe bloody diarrhea, anemia, emaciation, loss of appetite, weakness, and often death. If the dogs survive, they become carriers and are sources of infection for other dogs.

The disease is caused by protozoan parasites of the genus *Isospora*. These one-celled parasites, more commonly called coccidia, live and multiply in the intestinal cells of the dog, and in severe cases destroy the intestinal lining. A resistant oocyst stage of the parasite is passed in the stools. When first passed, the oocysts cannot infect other dogs, but they become infective by sporulating on the ground. Sporulation is a process of division of the protoplasmic mass inside the oocysts into a number of infective sporozoites. Other dogs become infected by eating material contaminated by the sporulated oocysts. The oocysts pass through the stomach, enter the intestine, break open, and release the sausage-shaped sporozoites. The sporozoites enter the intestinal cells, become round, multiply, and eventually destroy the cells.

Since very little is known about these parasites, research on coccidia in dogs is at present being conducted at the College of Veterinary Medicine. There are several species of *Isospora* in dogs, and it is not known how pathogenic each species is. We think that some species are more harmful than others. We do not know, either, where each species is located in the intestine and which stages in its life cycle are the most pathogenic.

Our first task was to determine what species of *Isospora* parasitize the dog and how to identify them. We examined 139 dogs for coccidia and found oocysts that ranged in size from 10 to 42 microns by 10 to 33 microns (a micron is one-thousandth of a millimeter, which is about the thickness of a dime). Whenever we found oocysts in a stool, we mixed it with 2.5-percent potassium dichromate and left it at room temperature for a week. This allowed the oocysts to sporulate but killed the bacteria which might harm them. We then studied the size, shape, and internal structure of the oocysts under the highest power of the microscope.

We identified three species of *Isospora: I. bigemina, I. rivolta,* and *I. canis*. This was the first time that the last species had been positively identified in this country. Formerly, it had been thought to be the same as a rather similar species in the cat. We found that the oocysts of each species differ markedly in size, shape, and internal structure, and that the species can be differentiated accurately on the basis of the sporulated oocysts. — *Virginia Ivens and Norman D. Levine*

Gilts' Utilization of Phosphorus During Gestation and Lactation

Availability of phosphorus from different sources may be more critical for gilts and sows during the stress of lactation than for growing swine. This is indicated by numerous reports of sows having posterior paralysis late in lactation or shortly after the pigs are weaned.

Research was undertaken to determine how well female swine utilize phosphorus from diets without phosphorus supplementation and with three sources of supplemental phosphorus: dicalcium phosphate, soft phosphate, and Curacao rock phosphate. Mature gilts were randomly allotted to treatment about 25 days *post coitum* and were fed a corn-soybean meal diet at the rate of 4 to 5 pounds daily during gestation and *ad libitum* during lactation. Without supplementation, the corn-soybean meal diet contained 0.72 percent calcium and 0.34 percent phosphorus. The supplemented diets contain 0.54 percent phosphorus. The gilts were confined to pens on concrete during gestation and were kept on partially slotted floors during an 8-week lactation.

In the first trial all gilts on the unsupplemented diet developed posterior paralysis. None of the gilts on the supplemented diets developed this condition. Gilts on the supplemented diets had higher values for bone calcium, phosphorus, and ash than gilts on the unsupplemented diets.

In a second trial, the group of gilts receiving dicalcium phosphate was the only one entirely free of posterior paralysis. The condition developed in two of six gilts on the unsupplemented diet, three of five receiving soft phosphate, and two of six receiving Curacao rock phosphate. As in the previous trial, bone calcium, phosphorus, and ash were reduced only in the gilts on the unsupplemented diet.

In a final trial, half of the gilts receiving dicalcium or soft phosphate also received 750 p.p.m. of a chelating agent (tetra sodium salt of ethylenediaminetetraacetic acid). Otherwise the gilts were handled as in previous trials.

The chelating agent was added because it had been shown to improve phosphorus utilization in rats. However, it had little or no effect on the sows. Five of ten sows on soft phosphate developed posterior paralysis, including some that had received the chelating agent. As in the previous trials, none of the sows on dicalcium phosphate developed the condition.

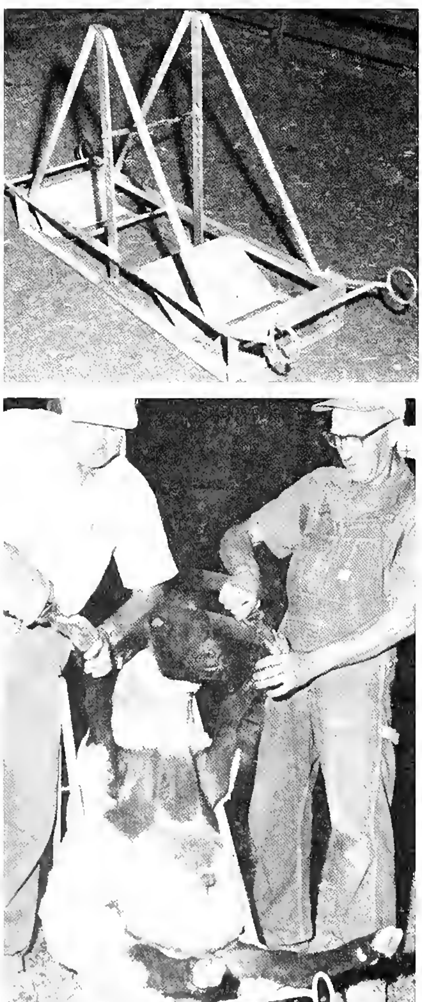
These results confirm the point that sows may often develop severe lameness or posterior paralysis if fed diets that are deficient in phosphorus or are supplemented with phosphorus that is not readily available. — *B. G. Harmon*

Sheep Sit in Chairs to Have Feet Trimmed

Foot health in flock management is often neglected because of the back-breaking labor involved. The "sheep chair" developed by extension workers in Virginia and adopted by Illinois workers eases the difficult foot-trimming job. It can also be used for easier treatment of leg and underline injuries of the animal.

The chair has a large and small seat and an adjustable back bar to accommodate sheep of varying sizes. On his haunches in the chair even the largest ram is helplessly immobile, which allows the trimmer to concentrate on the job of foot trimming.

The chair may be easily constructed of either wood or metal. The more lasting metal chair would cost about $20 if custom-built at a machine shop. Home construction costs would be less. Plans for the sheep chair are available through the University of Illinois Cooperative Extension Service. — *Lawrence A. Archart*



Sheep chair eases foot-trimming job.

Nine Species of Coccidia Are Found to Infect Swine

For many years we have known that pigs have coccidia in their intestines and that swine may be affected by coccidiosis in much the same way that chickens are. We have also known that pigs have their own species of coccidia which are different from those of other animals. There has been quite a bit of confusion, however, both about the number of species infecting swine and about the nature of their effects.

Dr. John M. Vetterling of the College of Veterinary Medicine has made a start toward straightening out the confusion. In a careful study of 403 pigs from Illinois and other states, he found that pigs harbor nine species of coccidia, of which eight belong to the genus *Eimeria* and one to the genus *Isospora*. Three of the species were new to science. He described them all in detail, so that they can be recognized by future investigators.

He found that 60 percent of the pigs raised on pastures, but only 2.4 percent of those raised on concrete, were infected with coccidia.

Dr. Vetterling also studied the complete life cycle of *Eimeria debliecki*, which is one of the commonest species and which had been thought to cause disease in pigs. He found that this species lives inside the cells that line the first part of the small intestine. Here it multiplies through two generations of multiple division, after which it produces oocysts with a heavy wall which pass out of the pig, develop to an infective stage on the ground, and are then ready to infect fresh pigs. Each oocyst which a pig eats is theoretically capable of producing about 4,000 new oocysts. It takes about 6½ days for oocysts to appear in the pig's droppings, and they continue to be passed for about 5 days. After that, unless the pig is reinfected, the infection is over.

The study showed that *E. deblieck*i is not pathogenic and does not cause disease. As many as 2.5 million infective oocysts were fed to 2-week-old pigs without producing any effects. Other species of coccidia, however, undoubtedly cause diarrhea and other disease symptoms, so the life cycles and pathogenicity of each species will have to be studied in turn. — *Norman D. Levine*

With Regulated Hours of Light, Pullets Start Laying at a Uniform Age

Chickens that reach maturity during the spring commence to lay at a younger age than those that reach maturity during the fall. This is a physiological response to the trend in day length. Increasing day length advances the onset of egg production, while decreasing day length delays it. The age at the onset of egg production may vary as much as 4 weeks seasonally at 40° N latitude; that is, at Urbana.

Some delay in the onset of egg production is desirable because it increases both the size of egg and the length of the hen's laying period. Excessive delays, however, do not further increase egg size or laying period. They only tend to increase the cost of bringing pullets to the point of lay.

Research conducted by the Poultry Division has led to the development of a lighting program under which pullets hatched at any season start to lay at the same age. This is accomplished by supplementing natural daylight to give day-old chicks 20½ hours of light per day. The amount of light is decreased ¼ hour per week to provide 15½ hours of light by 20 weeks. From 21 to 30 weeks, light is increased ¼ hour per week to reach a total of 18 hours, where it is maintained thereafter. Since maximum natural daylight at Urbana is only 15 hours, this schedule can be followed at any time of the

year by the appropriate adjustment of time clocks.

Flocks of White Leghorn pullets hatched at any season of the year reach a 10 percent rate of lay during their twenty-second week; 50 percent during their twenty-fifth week; and 80 percent during their twenty-seventh week. Such control over the rate of physiological development is desirable when pullets hatched at various seasons are used for nutritional or other types of experiments. — *D. J. Bray*

Mechanism of the Action of Adjuvants of Immunity

After several years of investigation in the College of Veterinary Medicine, a theory of antibody production was formulated. This theory is contrary to the commonly held belief that antibody is formed only in response to the presence of antigens (foreign substances) in the body. Rather, the theory holds that antibody formation depends on complexes formed by antigen and its specific antibody (*Illinois Research*, Fall, 1963).

Such a mechanism requires that low concentrations of natural antibodies, capable of combining specifically with all antigens that can elicit an immunologic response, be present in normal animals before they are exposed to antigens. The magnitude of the antibody response, other things being equal, would depend on the concentration of the natural antibody specific for a particular antigen.

On the basis of this theory it appeared possible to explain the effect of certain substances, known as adjuvants of immunity, which increase the magnitude of the antibody response. Freund's adjuvant (a mixture of mineral oil, killed tubercle bacilli, and an emulsifier) is a very powerful adjuvant when administered mixed with an antigen. An increased concentration of serum gamma globulin had been reported in rabbits injected with Freund's adjuvant. Since this fraction of the serum contains antibodies, it appeared conceivable that the adjuvant increased the concentration of natural antibodies, thus accelerating the formation of antigen-antibody complexes and the production of antibody.

To test this hypothesis. rabbits were injected with Freund's adjuvant, but received no antigen. At various times between 1 and 9 weeks after adjuvant treatment, serum from treated rabbits was injected into normal rabbits. The recipient rabbits also received an antigen, but no adjuvant.

Rabbits receiving serum from adjuvant-treated donors produced more antibody than rabbits receiving serum from untreated donors or no serum at all. Moreover, the magnitude of the antibody response of the recipient rabbits was correlated with the increase in gamma globulin in the serum of the donors. Thus, passive transfer by serum of the action of Freund's adjuvant was demonstrated, supporting the theory of antibody formation mentioned above. — *D. Segre, D. L. Dawe, and W. L. Myers*

Use of Detached Leaves Offers Advantages in Studying Plant Diseases

Whole plants, growing either in the field or the greenhouse, are used for most studies of plant disease. Sometimes, however, the investigator may not want to infect the entire plant, but may want to reserve a healthy portion for seed production or vegetative propagation. Other times he may want to infect separate parts of a plant with different pathogens or strains of a pathogen. Under these conditions, he may want to keep individual leaves, or portions of leaves, alive after detachment from the plant. Although detached leaves cannot be kept alive indefinitely, they may live long enough for the investigator to conduct certain disease tests or to culture certain fungi.

Techniques for detached leaf culture are usually very simple. Leaves of a few plants remain alive for several weeks in just water. Leaves of other plants, such as corn, become chlorotic within a week if they are in water only, but they remain alive several days longer when provided with an external source of sugar.

The breakdown of some plant leaves is delayed by adding plant kinins (such as benzimidazole, kinetin, or N^6-benzyladenine) to the substrate. These kinins prevent the breakdown of ribosomes, ribonucleic acid (RNA), mitochondria, and internal cell membranes, and keep the protein-synthesizing and energy-transforming systems of the cell intact.

New roots may be formed on the petioles of some plant leaves, thus preventing or even reversing the process of aging.

Detached leaves have recently been used in the culture of *Puccinia sorghi*. This is the first time that this fungus has been grown through a full life cycle without complete host plants. *P. sorghi* is an obligate parasite (cannot be grown on artificial media) and requires two host plants, corn and *Oxalia corniculata*, to complete its life cycle.

The uredial, telial, and sporidial stages of *P. sorghi* were successfully cultured on detached corn leaves which were kept alive by floating them on the surface of a 5-percent sucrose solution containing 20 p.p.m. of kinetin or of N^6-benzyladenine. Resistance or susceptibility to the fungus was the same on detached leaves as on leaves of the whole plant. It was therefore possible to use the detached leaves for studying the genetics of host reaction and the physiologic specialization of the pathogen.

Detached leaves of *O. corniculata*, the alternate host of *P. sorghi*, were treated with 35 p.p.m. of 3-indoleacetic acid to induce root formation. These leaves were used to culture the pycnial and aecial stages of *P. sorghi*.

Work is now under way using detached leaves in genetic studies of *P. sorghi* and other pathogens. Some of the advantages offered by this method are the rapidity of fungal generations, economy of fungus and host material, purity control of pathogen genotypes, ease of manipulation and observation, and control of environment. — *A. L. Hooker*

FARM BUSINESS TRENDS

THREE relatively new economic developments are having a profound influence on Illinois farming and farm people. They are industrialization, supermechanization of agriculture, and foreign demand for our principal crops.

New industrialization. Recently many new industries have moved into formerly agricultural areas. These industries compete strongly with farming for labor. Costs of hired farm labor have risen sharply, and will rise much more if the industrial boom continues. Rising costs of hired labor favor farms where the farmer and his family do most of the work. Only the most outstanding managers will be able to employ hired labor profitably.

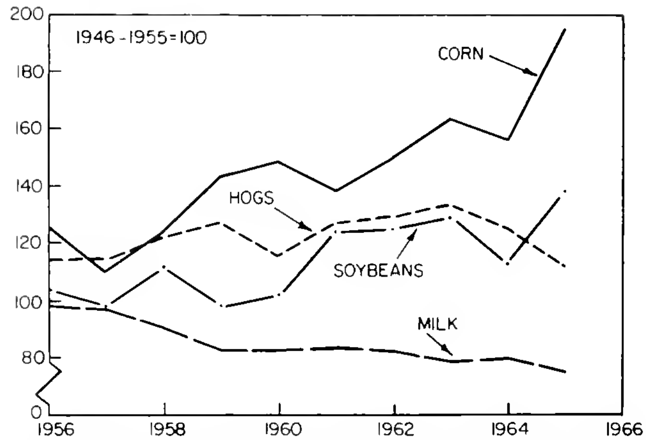
Industries compete not only for the labor of the farm hand but also for that of the farmer and his family. The increasing opportunities for nonfarm employment tend to reduce the number of competitors for farmland. This speeds up the enlargement of farm units to more profitable levels.

Supermechanization. By supermechanization of agriculture we mean the use of big-capacity field machinery and the mechanization of livestock production. Farmers who have large field machinery and enough land to use it profitably often cannot afford to stop to care for livestock. They drop the livestock enterprises and concentrate on crop production.

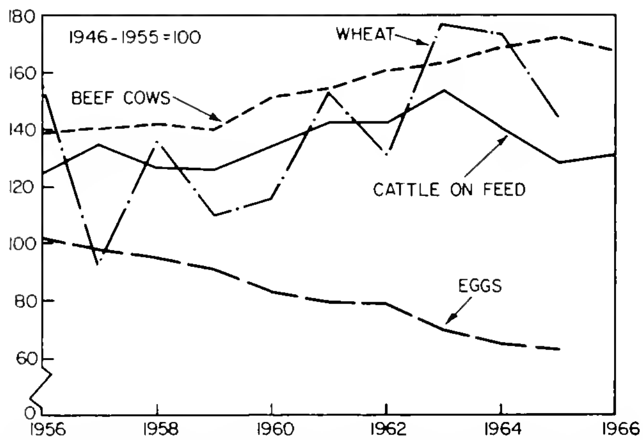
As some farmers quit livestock production, others can increase their livestock enterprises. The mechanization of livestock production makes it possible to greatly increase the output per man.

Foreign demand. During recent years, a resurgence of foreign demand, especially for corn and soybeans, has reached into Illinois over the great rivers which border and bisect our state. This development tends to make our feed prices higher than those farther west. It favors the production of grain for sale, but puts our livestock producers at a disadvantage as compared with farmers in more western areas.

Livestock industries squeezed. Although Illinois farmers increased their share of the nation's pork business for many years, they lost a little ground in 1965. The production and feeding of beef cattle have been increasing in Illinois, but not so fast as in the nation as a whole. Production of milk, eggs, and chickens has been decreasing. — *L. H. Simerl, Extension Economist, Agricultural Marketing*



Production of corn, hogs, soybeans, and milk in Illinois; expressed as indexes with 1946-1955 equaling 100.



Illinois wheat and egg production and numbers of cattle on feed and beef cows on farms, January 1; expressed as indexes with 1946-1955 equaling 100.

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Summer, 1966

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Special summer training for high school students is part of the program at the Burnsides Research Laboratory. The former participant pictured here is studying dried paper chromatograms (page 8).

Volume 8, Number 3 **COLLEGE OF AGRICULTURE** **URBANA, ILLINOIS**

ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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Margery E. Suhre....Editor, Illinois Research

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NEWS AND VIEWS

American universities are having to accommodate themselves to new dimensions in education. The dynamism of the educational institutions themselves provides one impetus for change, but other forces for change are arising outside the universities.

Government agencies, for example, are turning to the universities for information that will help people to reach decisions in a changing society. Industry is not only seeking technical knowledge, but is also asking the universities to answer questions concerning the relationship of industries to one another, to their staff and workers, and to society in general. Political, social, and cultural leaders are asking similar questions. Underlying the questions are concern about the impact of technological change on business and industry, with the attendant effects on individuals and the family; and also a concern about our nation's international posture and defense, especially as we are committed to helping other nations emerge into twentieth-century technology.

Intermingled with the broad questions and concepts of human behavior and living is the need to face the continued hard economic facts of life — production, efficiency, resource utilization and conservation, trade, money and credit, and the need for developing managerial skills necessary for integrating available resources into a national system of production, processing, and distribution.

The forerunner of effective change must be knowledge. In the case of agriculture, this knowledge must be about plants, animals, the environment, particularly soil, and agribusiness. Knowledge comes in pieces, which bit by bit can be integrated into a system or applied to the solution of problems in an existing system. Many of the people seeking the "bits and pieces" of knowledge are engaged in basic research, or the search for fundamental information. The integrator, more interested in applied science, has the challenging job of putting the bits and pieces together into a system for the production, processing, or distribution of food.

The past effectiveness of agricultural research and education, much of it conducted by the land-grant universities, can be documented in terms of total production and in the nutritious diets available to the American people. Today the research, teaching, and off-campus educational programs of the land-grant university have an increasing relevance to the needs of society and the individuals within that society. — *Orville G. Bentley, Dean of the College of Agriculture*

The Importance of Management in CONFINEMENT SWINE PRODUCTION

A. H. JENSEN

MANAGEMENT is the key to success in confinement swine production. Although pace-setting Illinois producers have a wide knowledge of nutrition and feeding, their greatest asset is good management ability.

Good management means: (1) correctly using your knowledge of feeding and breeding; (2) guarding your animals' health by following good sanitation and disease-prevention practices; (3) selecting the best market for the quality of hog produced; and (4) deciding the kind and extent of housing and environment control appropriate to the production unit. This last point is especially important in confinement production.

The necessity for good management has been emphasized by research done at the Moorman Swine Breeding Research Farm since it was established in 1960.

Slotted floors

Some of the research at the Moorman Farm has been on the use of slotted floors. This recent innovation was shown to reduce labor, eliminate bedding, and keep animals clean and dry. These benefits depend upon good management. With poor management, animal performance may also be poor.

One important aspect of management is the width and spacing of slats. When pigs were put on slats only 1¼ inches wide and ½ inch apart, the animals behaved very much like other pigs on 4- or 5-inch slats spaced at 1 inch. However, pigs on 1¼-inch slats spaced at 1 inch gained much more slowly (Table 1).

The difference in performance began to be obvious when the pigs weighed about 70 pounds. Pigs on the narrow slats with the 1-inch spacing became reluctant to move around and consequently didn't eat as much as the other pigs. They also developed many foot and leg injuries. By contrast, the 1-inch spacing with 4- and 5-inch slats did not cause any injury and the animals performed very satisfactorily.

Housing environment

Effects of environment changes were also investigated. Temperature extremes, in particular, markedly affected performance levels.

To evaluate housing and environment during the winter, littermate pigs were randomly assigned to three different buildings. Two buildings were completely enclosed and insulated, and one was heated with a gas-fired space heater. The third building was open on the south.

In the open-front building, temperatures varied by 72 degrees as the pigs were going from 30 to 105 pounds (Table 2). Pigs in this building metabolized much of their feed energy to maintain body warmth. Consequently they gained 1/10 pound less per day than the other pigs, and required significantly more feed for a pound of gain.

While the pigs were going from 105 pounds to 240 pounds, the outside temperatures modified some-

Table 1. — Daily Gain of Growing-Finishing Swine on Solid Concrete Floors and on Slotted Floors With Different Slat Widths and Spacings

Type of floor	Slat width, in.	Slat spacing, in.	Pig weights, lb.		Average daily gain, lb.
			Initial	Final	
Solid concrete			40	200	1.42
Concrete slats	5	1	41	205	1.45
Wood slats	4	1	41	199	1.40
Wood slats	1¼	½	40	204	1.45
Wood slats	1¼	1	40	170	1.15

Table 2. — Effects of Housing Environment on Performance of Growing-Finishing Swine During Cold Weather

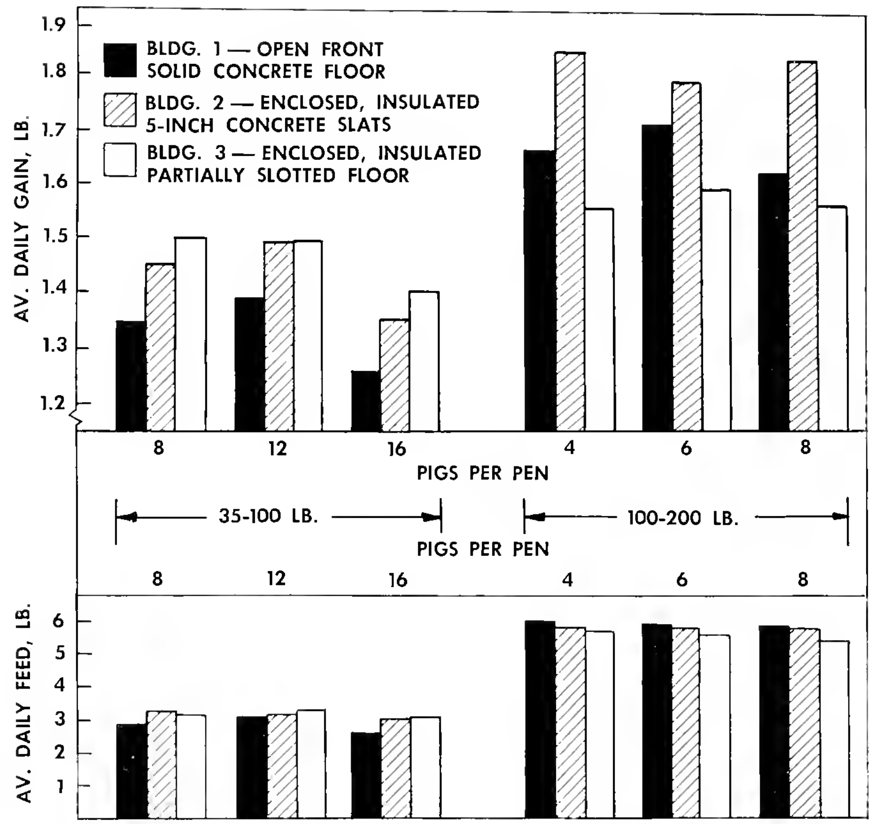
Type of housing	Temperature, °F.		Aver. daily gain, lb.[a]	Aver. daily feed, lb.	Feed per lb. of gain, lb.
	Range	Mean			
Pigs 30 to 105 lb. (December-January)					
Enclosed, insulated, heated[b]	60–75	71	1.76	3.33	1.89
Enclosed, insulated, unheated	36–56	50	1.76	3.61	2.05
Open-front	−11–61[c]	21[c]	1.65	3.96	2.40
Pigs 105 to 240 lb. (January-March)					
Enclosed, insulated, heated[b]	60–75	68	1.80	6.36	3.53
Enclosed, insulated, unheated	35–75	56	1.80	6.31	3.50
Open-front	−5–64[c]	34[c]	2.00	7.37	3.68

[a] Each figure represents an average for four groups of eight pigs each.
[b] Space heater thermostat was set at 70° F. from 30 to 80 pounds; 60° F. from 80 to 240 pounds.
[c] Outside temperatures. Building was open to the south. Enough straw bedding was provided to keep sleeping area dry.

A. H. Jensen is Professor of Animal Nutrition, Department of Animal Science.

what, but the feed efficiency was still in favor of the animals in the enclosed buildings. Animals in the open-front shed consumed the most feed per day. Although they had the highest rate of gain, they were using much of their feed energy for body heat and still required more feed for a pound of gain than the other pigs.

If pigs are to realize their full growth potential, they need a modified environment in hot weather as well as in cold weather. High temperatures cause pigs to eat less and consequently gain less than they would normally.



How number of pigs per pen affects daily gain and feed intake. The test began on July 31 in Buildings 2 and 3 and on August 14 in Building 1. On September 20, when pigs weighed about 100 pounds, the number per pen was cut in half. The test lasted until November 15 in Buildings 2 and 3 and until November 22 in Building 1. (Fig. 1)

Number of pigs per pen

Another aspect of management that has been investigated is the effect of numbers of pigs per pen upon the animals' performance.

Groups of 8, 12, and 16 pigs were kept in each of three buildings. Pen size was adjusted so that each pig had the same amount of floor space. Except for number of pigs per pen and type of building (Fig. 1), management practices were uniform.

Average daily gain and average daily feed as the pigs went from 35 pounds to 100 pounds are shown in Figure 1. During this period, the 16-pig groups averaged 1.33 pounds of gain per day, compared to 1.43 pounds for the 8-pig groups and 1.45 pounds for the 12-pig groups. The 16-pig groups consumed the least amount of feed, 2.94 pounds per pig per day. The 8-pig groups consumed 3.16 pounds per pig per day, and the 12-pig groups, 3.22 pounds.

When the pigs reached 100 pounds, the numbers per pen were cut in half, to insure that all pens would have adequate floor space. No significant differences were found among the 4-, 6-, and 8-pig groups as they went from 100 to 200 pounds (Fig. 1). This period of growth occurred from September to November, so the pigs were not affected by warm temperatures as they had been during the first part of the test.

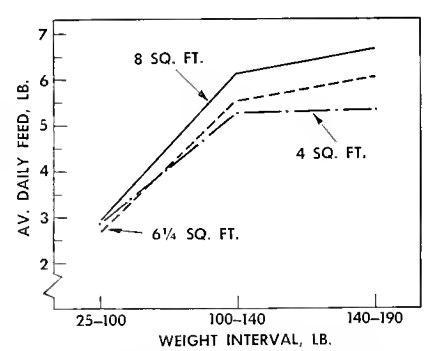
Floor space allowances

How much floor space does a growing-finishing pig need? To answer this question several experiments were conducted in different confinement housing units with totally or partially slotted floors. Under these conditions, pigs did not need as much floor space as formerly believed (see Illinois Extension Circular 824). Recommended *minimum* space allowances, based on test results, are given below.

Weight of animal, lb.	*Square feet per animal* *Winter*	*Summer*
25 to 40	3	3
40 to 100	4	4
100 to 150	6	6
150 to 210	8	9

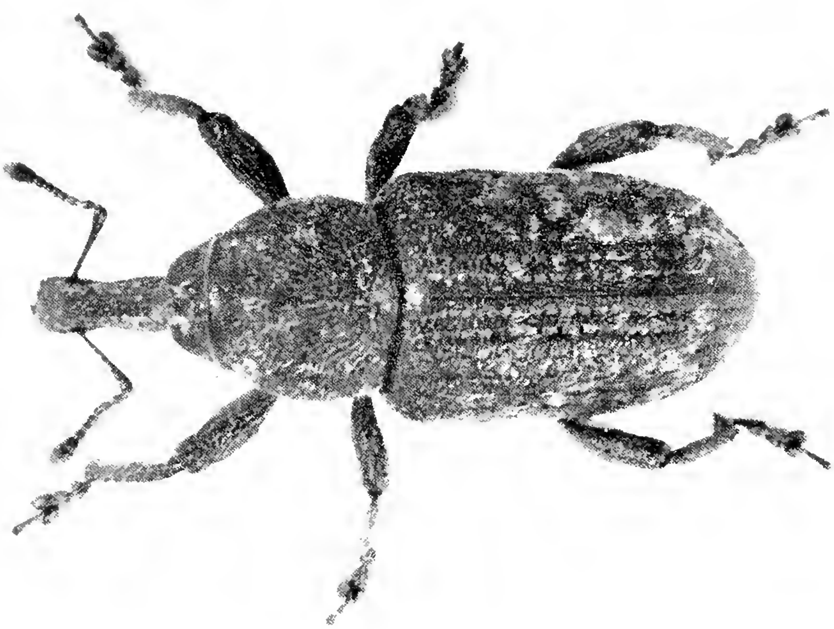
On solid floors, pigs need at least 50 percent more space than recommended above to keep clean.

The effect of space allowance on voluntary feed intake is shown in Figure 2. Four square feet per pig was enough for pigs up to 100 pounds in weight, but was completely inadequate for pigs over 140 pounds. It should be remembered that the adverse effects of crowding are further increased by high temperatures.



Effect of floor space on feed intake of pigs at different weights. (Fig. 2)

Because of the growing-finishing pig's rapid change in size and weight, confinement buildings should be designed for specific sizes and age of animals, so that the appropriate environment can be provided.



THE PALES WEEVIL . . .

A new insect problem for growers of Christmas trees in Illinois

R. G. RENNELS

CHRISTMAS TREE growers in Illinois are learning to recognize the pales weevil, *Hylobius pales* (Hbst.). Long a problem in eastern and southern states, this insect has only recently become important in Illinois, although it has been present here for many years. Infestations are on the increase, and the owners of some Christmas tree plantations are becoming quite concerned about the damage.

Life cycle

To understand the circumstances responsible for this weevil's rapid change in status, we need to consider a few aspects of its life history and habits.

Adult weevils feed at night on the bark of seedling pine and on the small branches of larger pine, eating down to the sapwood. As a result, seedlings often die and the branches of larger trees are either covered with pitch or have dead terminal growth. Eggs are laid during the spring and summer in the bark of fresh stumps or in the bases of trees that have been recently killed or are in poor vigor. After larvae emerge from the eggs, they remain in the trees or stumps while they go through the pupal stage and are transformed into adult weevils.

Larvae do no damage since they feed only on the inner bark of stumps and of trees already in declining health. They are important only as the source of the destructive adult weevil populations.

Environment is favorable

With this knowledge of the weevil's life cycle, we can see that man has created a favorable environment for this insect in Illinois. During the past 40 years thousands of acres of pine have been planted in the state for various purposes. For the past 15 years many acres have been planted specifically for Christmas-tree production.

These plantings, almost from the outset, provided an abundance of food for adult pales weevils. No destructive populations developed as long as the larvae did not have many favorable habitats (fresh stumps and the bases of weakened trees). Now, however, large numbers of fresh stumps are becoming available every year as older plantations are thinned and Christmas trees are harvested. These stumps provide favorable sites for immature pales weevils, and the result has been a sharp upward trend in populations.

Control measures

Unless natural controls intercede to drastically reduce weevil numbers, artificial control measures will be needed. The most logical measure is to poison stumps so that the weevils cannot spread from one stump to the next. Sodium arsenite (Atlas D, debarking compound) and benzene hexachloride (BHC) have been successfully used in the eastern states for this purpose.

Other chemicals are now being tested by the Forestry Department to determine the most economical and safest means of satisfactory control. Biological and ecological studies now being made may also provide leads to non-chemical control measures.

Pales weevil larvae in Scotch pine stump.

R. G. Rennels is Associate Professor of Forestry.

LISTERIOSIS IN CATTLE AND SHEEP

Research confirms the suspicion that poor-quality or spoiled silage may cause listeriosis or "circling disease"

ARDEN H. KILLINGER

For a long time, farmers have suspected that "circling disease" or listeriosis in cattle and sheep may be due to feeding poor-quality or spoiled silage.

There are several good reasons for this suspicion. Most outbreaks in Illinois occur between December and May, when cattle and sheep are in the feedlot and are being fed silage. Outbreaks often start 3 or 4 weeks after the silo is open, and seem to occur where poor-quality or spoiled silage has been detected. Similar observations have been made in other states and in Iceland, Holland, and Germany.

Disease symptoms

Among the symptoms of listeriosis in sheep are depression, weakness, fever, paralysis of the tongue and jaw, and excessive salivation. Animals also lack coordination, lose their appetite, walk in circles, and push their heads against walls and other objects. These symptoms are followed by progressive paralysis, coma, and death.

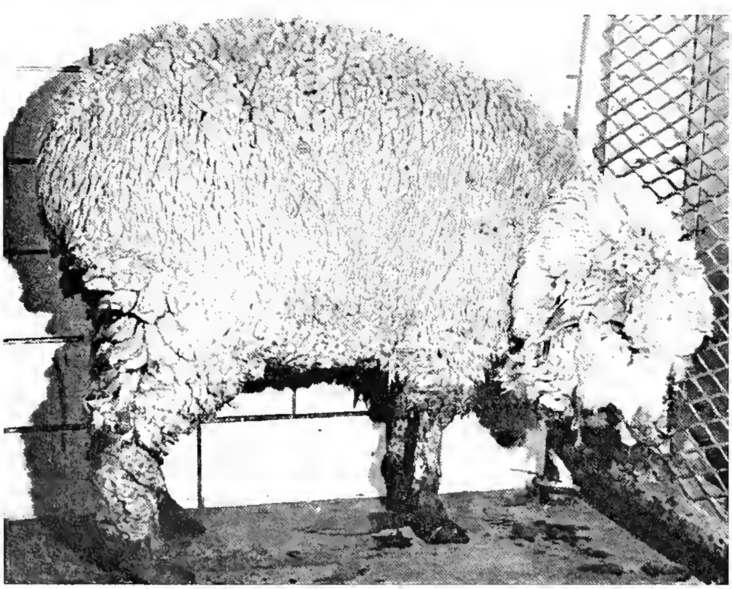
Principal symptoms in steers are a glassy, dazed expression of the eyes, partial paralysis of the lower jaw, and excessive salivation. Affected animals become prostrate and go into a coma three or four days before death.

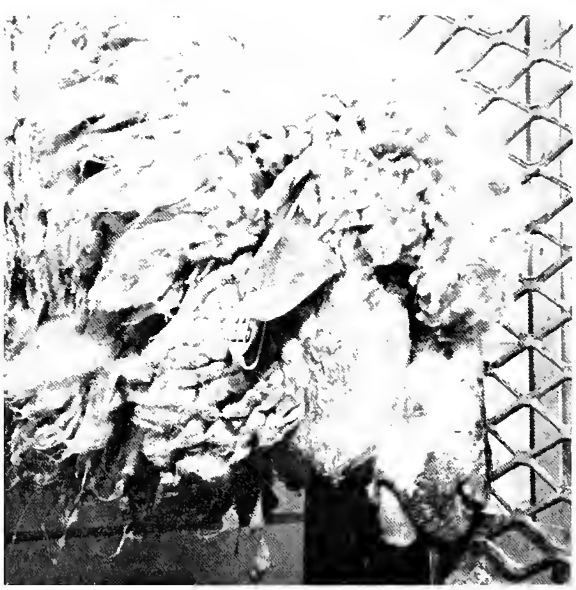
Cause and diagnosis

The organism causing this disease is a bacterium known as *Listeria monocytogenes*. In 1938 three University of Illinois staff members — Drs. Robert Graham, Glen Dunlap, and C. A. Brandly — were the first to isolate the organism from cattle and sheep in the United States.

L. monocytogenes invades the base of the brain, producing encephalitic changes that account for the clinical symptoms described above. A pathologist can recognize characteristic brain damage after specimens from the brain are fixed in formalin, embedded in paraffin, sectioned, and stained. "Cuffs" of cells surround the blood vessels and microabscesses are visible. Sometimes *L. monocytogenes* can be detected within the inflammatory cells near the outer margin.

The characteristic changes in the brain enable the pathologist to assist the veterinarian in making a rapid presumptive diagnosis of listeriosis. It takes a while, however, to confirm this diagnosis, for it is sometimes





An inclination to lean against the wall and partial paralysis of the ear, tongue, and lower jaw are typical symptoms of listeriosis in sheep.

difficult to isolate *L. monocytogenes* by bacteriologic culture from fresh tissue. After "cold enrichment," or storage of the brain at 4° C. for 1 week to 3 months, the bacterium grows readily in culture. Before the Veterinary Diagnostic Laboratory of the State Department of Agriculture can confirm a diagnosis of listeric infection, a specimen of brain tissue is given cold enrichment and then is cultured every 2 weeks for 12 weeks.

Every year the Veterinary Diagnostic Laboratory confirms a diagnosis of listeriosis in 10 to 15 flocks or herds.

Research on disease's spread

Research on listeriosis is now being conducted in the College of Veterinary Medicine. The work is supported in part by a grant from the Communicable Disease Center of the U.S. Public Health Service. Objectives are to find the source of *L. monocytogenes* in nature, the way the infection spreads, and the manner in which the bacterium produces disease.

Because of the association which has been made between poor-quality silage and listeriosis, silage is receiving special attention. Two possible sources of *L. monocytogenes* in silage have been suggested. First, the silage in the feed bunks may be contaminated by the urine or feces of small mammals or birds that are carriers of the infection. Second, the silage itself may be contaminated with the organism.

These hypotheses are being tested at the Dixon Springs Agricultural Center in Polk County. The University of Illinois maintains about 1,000 cattle and 1,000 sheep at Dixon Springs. Every year 5 to 10 cases of listeric infection occur in this livestock.

During the 1964–65 silage-feeding season at Dixon Springs, *L. monocytogenes* Type 4 was isolated from the brains of four sheep which had died. Early in 1965 *L. monocytogenes* Type 1 was isolated from a pool of the liver and spleen of five mice which were caught under the feed bunks from which silage was being fed to sheep. Attempts to isolate the organism from another group of five mice, from silage, from the tissues of turtles, and from deer feces were not successful.

New technique developed

The failure of these attempts could, of course, mean that the organism was not present, but such an assumption could be wrong. *L. monocytogenes* is difficult to isolate in nature because of the multiplicity of bacteria in soil, silage, and the nose and feces of animals. It was therefore necessary to develop procedures for selectively enhancing the growth of *L. monocytogenes,* so that the organism could be easily isolated.

Such procedures were developed for detecting the organism in silage. The procedure was based on the knowledge that *L. monocytogenes* will grow in mouse tissue, although mice are ordinarily resistant to the usual bacteria present in silage.

A 30-gram sample of silage was put in a 3-ounce plastic cup and the cup was filled with tryptose broth. After 2 weeks of "cold enrichment," a sample of this silage was injected into mice. Some of the mice died after 5 or 6 days. Surviving mice were sacrificed on the seventh day, and their livers and spleens were ground and cultured on tryptose broth which had been solidified with agar. Within 24 hours, small colonies of the organism developed on the solid medium. When viewed with oblique light in a dissecting microscope, the colonies had a characteristic blue-green color which distinguished them from bacterial colonies of other organisms.

Sometimes poor-quality or spoiled silage will contain bacteria, other than *L. monocytogenes*, which will kill mice and thus interfere with the isolation of *L. monocytogenes.* By slightly modifying a process developed in Germany, we have recently been able to isolate *L. monocytogenes* directly in a potassium thiocyanate bacteriologic culture medium without resorting to mouse inoculation.

Spoiled silage may be hazaradous

This new procedure has permitted more extensive studies on poor-quality or spoiled silage. In January, 1966, silage samples were collected from various areas of trench and upright silos at Dixon Springs. *L. monocytogenes* Type 4b was found in pockets of spoiled silage, but not in good-quality silage.

Results with this new technique thus confirm the opinion that feeding low-quality or spoiled silage may cause listeriosis.

Proper ensiling kills organism

That *L. monocytogenes* will not survive a good ensiling process has been demonstrated by experimental work done in cooperation with Dr. Frank Hinds and Dr. T. R. Cline of the Animal Science Department.

Glass freezing jars were used as "silos." They were packed part way with chopped alfalfa, which was seeded with a culture of *L. monocytogenes.* The remaining space in the jar was filled with sterile sand in a plastic bag and the jar was tightly covered. Three weeks in an incubator completed the ensiling process. Samples taken after this time indicated that the organism had been destroyed.

It is possible that good-quality silage which has been properly ensiled can be contaminated with spoiled silage if mechanical silo unloaders are used without supervision. One isolation of *L. monocytogenes* was made from a sample of high-moisture corn.

Sheep may be carriers

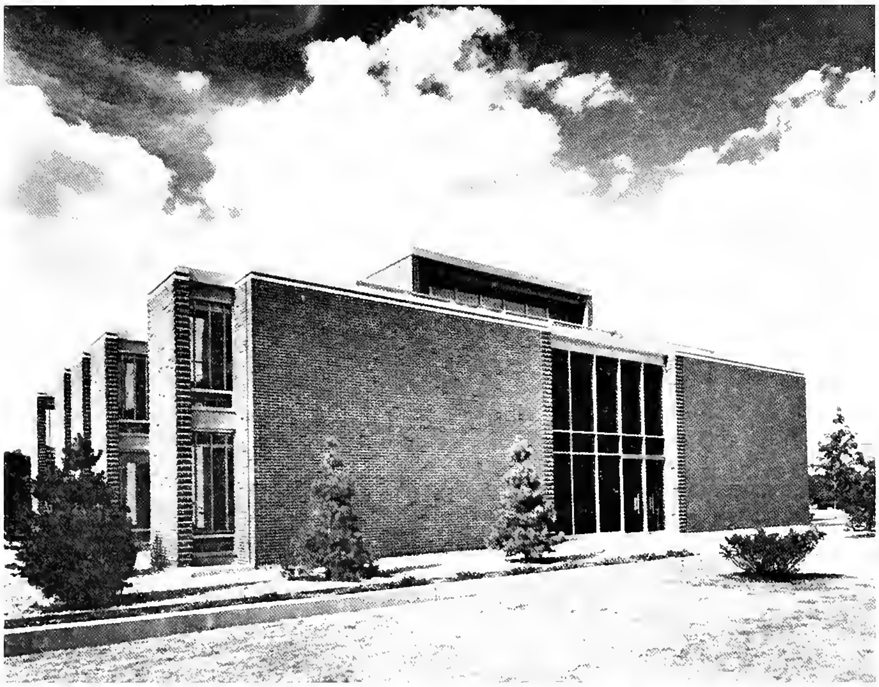
When the silage samples were collected at Dixon Springs, nasal swabs were taken from 10 sheep which were being fed silage from one of the trench silos. *L. monocytogenes* was isolated from the nasal cavities of two of the sheep, although the sheep were not sick. Thus, in a flock of sheep receiving contaminated silage, some may become carriers without developing symptoms themselves.

Arden H. Killinger is Associate Professor of Veterinary Pathology and Hygiene.

A SOUND BASIS FOR OUR FOOD CHOICES

The ultimate goal of research and student training at the Burnsides Research Laboratory

F. A. KUMMEROW



The Burnsides Research Laboratory was made possible by a gift from Miss Ethel Burnsides of Paris, Illinois; state building funds; and funds from the National Institutes of Health. The building was activated in June, 1963, with a three-day symposium. Addresses given at the symposium were published in 1965 by Charles C Thomas Publishing Co. under the title, ***Metabolism of Lipids as Related to Atherosclerosis.***

Now a college student, John Morton (right) participated in the 1963 summer program for high school students. Here he is studying printed tape from the Tricarb scintillation spectrometer for measurement of radioactivity.

THE BURNSIDES Research Laboratory represents an investment which is paying dividends in two ways. It offers a means of learning more about the relationship between diet and aging. And it provides facilities for training students in this area of research.

A healthful diet the goal

The ultimate goal of the research program is to provide a sound basis for our food choices. We in America are fortunate in having so many foods available that choices are possible. Food habits largely dictate what we choose to consume. However, a growing concern for optimum health is also influencing many people in their selection of foods.

If we choose foods for their health value, it is important that the choice be made on the basis of facts and not fiction. For example, is there indeed a valid connection between the consumption of meat, poultry, and dairy products and the incidence of heart disease? Are the "polyunsaturated" fats in salad oils better for us than animal fats?

The polyunsaturates become significant because, if they are eaten in large amounts, they lower the cholesterol level in the blood serum. If, in addition, animal fats are eliminated from the diet, the serum cholesterol is lowered still further. This interesting observation is important to many physicians because the serum cholesterol level has served as an aid in diagnosing heart disease.

F. A. Kummerow is Professor of Food Chemistry and Director of the Burnsides Research Laboratory.

They believe that reducing the serum cholesterol level by diet may lower the risk of developing coronary heart disease.

Suppose, however, that we are told to eat significantly less saturated fat (contained in meat) or cholesterol (contained in eggs). While reducing our cholesterol level, we might develop serious deficiencies in protein, iron, and B complex vitamins. The unknown factor is the meaning of "significantly less." Does it represent a drastic or a slight decrease in the consumption of milk and meat food groups? With a drastic reduction, a growing child will rapidly develop acute symptoms of malnutrition unless he gets adequate substitute protein, mineral, and vitamin supplements. Adults may not develop such symptoms as readily, since their nutritional needs are not so great as those of a growing child.

Where are the substitute proteins to come from if the consumption of meat and milk is greatly reduced? High-protein vegetables do not supply all the different kinds of amino acids needed in the diet. And such meat substitutes as fish are not available in large enough amounts to satisfy the total protein needs of all Americans.

The diets that have been used in clinical studies of the "polyunsaturates" indicate that the milk and meat food groups have been recognized as sources of protein. Even so, practicing physicians may not have the basic knowledge needed to convert experimental diets to commonly available food items. Certainly the layman does not have this knowledge.

Lipoproteins need study

Before an optimum diet can be recommended with confidence, many questions need answering. A number of the questions now being studied in the Burnsides Laboratory involve the lipoproteins. These essential components of the blood are formed from lipids in the lymph (triglycerides and phospholipids), endogenous cholesterol in the liver, and a number of complex proteins. The triglycerides and phospholipids are derived from both the "hard" fats in the milk and meat food groups and the "polyunsaturates" in salad oils.

Since lipoproteins contain polyunsaturated fatty acids, they are unstable to air and are difficult to work with in isolated systems. New techniques have recently become available, however, for studying the lipoproteins and their relationship to other components of the blood. Discovering the site of their action is of the utmost importance in opening up new doors to the complex biochemistry that is involved in the development of atherosclerosis.

Training of students

Because of all the perplexing problems involved in studying the relationship between diet and aging, it is important to train students who can carry on this work. Since 1950, the University of Illinois has been offering graduate instruction in this area and has conferred Ph.D. degrees on 45 students. These graduates are now directing research in six different locations in Illinois, in 10 other states, and in Canada, Great Britain, France, Greece, Israel, Egypt, Lebanon, India, Japan, and Korea. Although their specific interests vary widely, the main area of research involves the utilization of fats and oils as foods and their relation to human health.

To help insure a continuing crop of graduate students in all areas of science, a program was started in 1960 to interest superior high school students in scientific research. The program has been supported by the Illinois Heart Association since its beginning and by the National Science Foundation since 1962.

Participants in the program serve as junior associates to experienced research staff for 8 weeks during the summer. At the start of the program, they receive orientation in the techniques of laboratory work. Throughout the 8-week period, they have laboratory instructors to help them. They also participate in a series of discussions about various fields of science. Every effort is made to acquaint the students with the realities of scientific research — the careful checking and routine repetition, as well as the excitement of new discoveries.

About half of the students work in the Burnsides Laboratory, and half work in other laboratories — agronomy, animal science, chemistry, dairy science, horticulture, plant pathology, and veterinary pathology. They live in University dormitories with counselors to guide them and give personal help.

Most of the participants have come from Illinois. Applicants who live in this state are first screened by local committees, and final selection is made by a statewide committee of physicians and high school and university teachers. Out-of-state participants are selected after careful evaluation of their applications, each of which includes a 1,000-word essay. The program has grown from two students in 1960 to 44 in 1966.

Now that the program has been operating for six years, it is possible to make some evaluation of its effectiveness. One goal of the program has been to encourage students to continue their education and especially to follow a career in science. It is noteworthy that all 85 of the participants who have finished high school have gone on to college and that the two participants in 1960 are now in graduate school. Slightly more than half of the 85 are enrolled at the University of Illinois. A very high proportion have received scholarships.

Letters and comments from the students show that participation in the program was a stimulating and rewarding experience for almost all. A few students, after exposure to research work, have decided that they don't want careers in physical or biological sciences. Most students, however, have been stimulated in their desire to continue their education in science and to obtain advanced degrees.

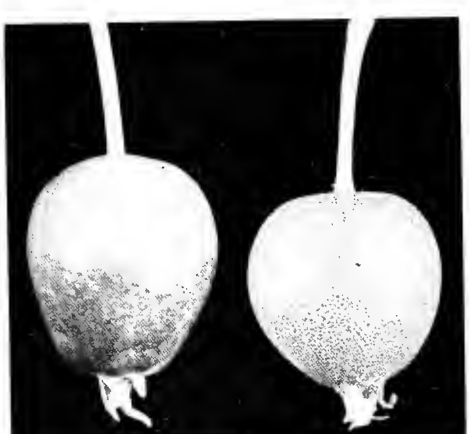
Russet Formation in the GOLDEN DELICIOUS APPLE

ROY K. SIMONS

A MAJOR problem facing the grower of Golden Delicious apples in Illinois is russeting or cork formation on the skin surface of the fruit. Even so, Golden Delicious is one of the most popular and widely grown apples in the state, leading all winter varieties in production.

For the past 10 years the Department of Horticulture has been conducting research on the development of russet in Golden Delicious apples. Both commercially grown fruit and fruit from the Experiment Station orchards have been included in the studies.

The 25-year-old Golden Delicious tree above produces russeted fruit on the part of the trunk marked "R"; normal fruit on the part marked "N." Arrow indicates point of transition between the normal and russet areas. (Fig. 1)



Normal fruit (near right) and russeted fruit (far right) 42 days after fruit set. They were produced on the tree illustrated in Figure 1. (Fig. 2)

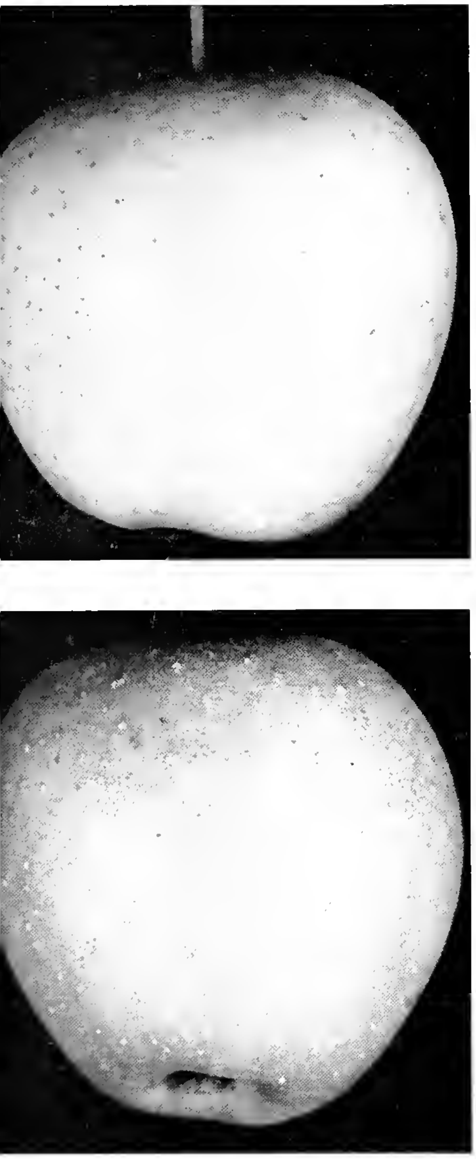
Trees with russeted fruit have been found in commercial orchards throughout the state. Russeting may be divided into two general types — that due to a sport or mutation of the tree and that due to frost, mechanical injury, or other cause. Russet sports of Golden Delicious have been observed as whole trees, as individual limbs, and as spurs bearing russeted fruit.

Cell development of the outer cortical region was found to be different in these russet sports than in normal fruits. Very young russeted fruits appeared normal, but cork formation could be observed by 20 days after fruit-set, and after another 10 days it was visible over the entire surface of the fruit.

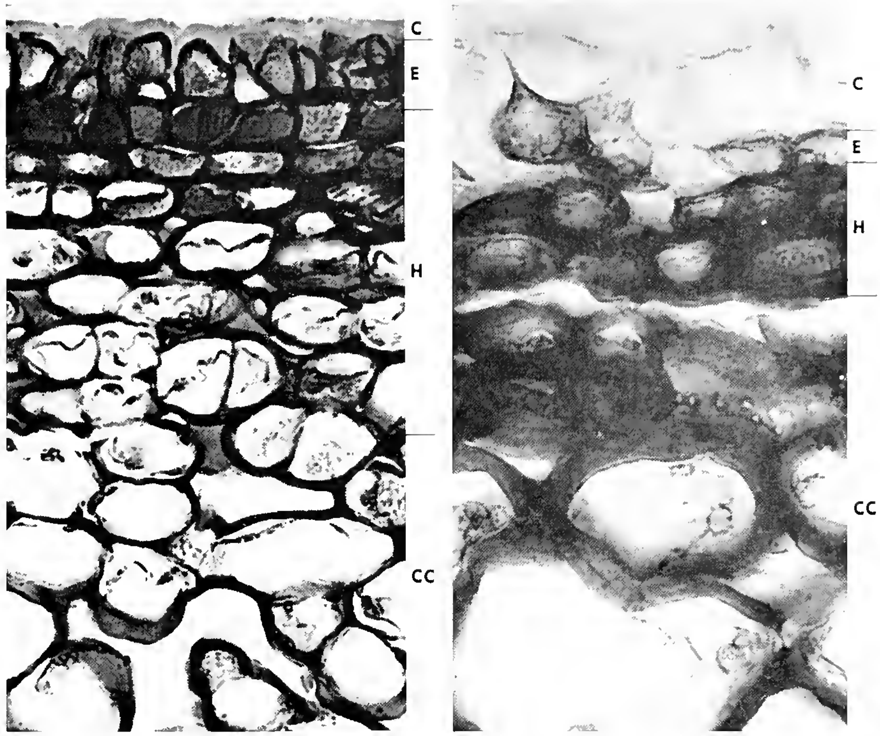
By 14 days after fruit set, cells of the hypodermal region (which lies between the epidermal layer and the large fleshy cells of the fruit) were 25 percent larger in normal fruit than in the russet fruit. Similar differences were found in the cortical region (large fleshy cells) of russeted and normal fruit. The crushing effect of the hypodermal cells in russeted fruit was transmitted to fleshy cells many layers deep within the fruit.

Russeting found on russet sports appears to develop less violently and less rapidly than russeting induced by frost or mechanical injury. Russet is not apparent in russet sports until 30 days after full bloom. When russet is induced by frost or mechanical injury, however, disruption of epidermal, hypodermal, and cortical cells is evident immediately. Also, frost not only produces russet, but retards the cuticle development in the young fruit.

Roy K. Simons is Professor of Pomology, Department of Horticulture.



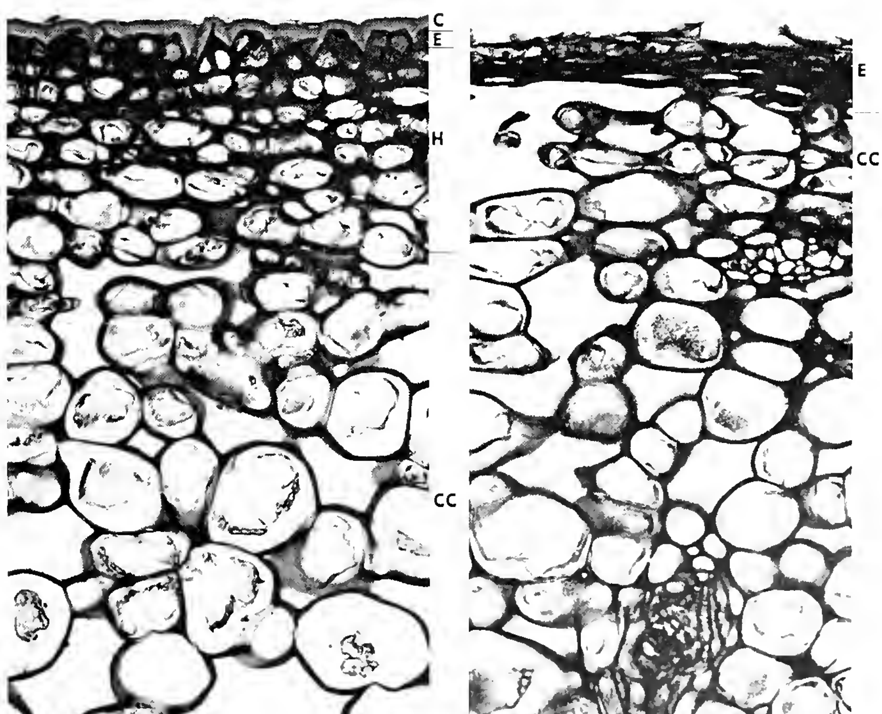
At maturity contrast is shown between normal fruit (top) and russeted fruit (bottom). (Fig. 3)



Photomicrographs of outer protective covering and cortical tissue of a normal Golden Delicious apple 44 days after fruit set (left) and at maturity (right). C, cuticle; E, epidermis; H, hypodermis; CC, cortical cells. Left X 225; right X 400. (Fig. 4)

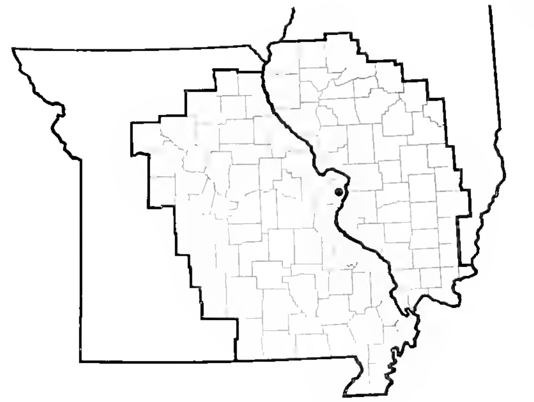
Although russeting develops slowly in russet sports, it covers 95 percent of the surface at maturity. Russeting induced by frost or mechanical injury may cover the entire surface of the fruit or it may cover only small isolated areas.

Although Golden Delicious often produces bud sport mutations, as yet none have been found resistant to russet. It is desirable that growers and nurserymen constantly evaluate new sports in an effort to discover one with russet resistance.



Photomicrographs (X 128) of transverse sections from fruit shown in Figure 2. Normal apple is at left; russeted apple, at right. For meanings of letters see legend for Figure 4. Cuticle, epidermal, and hypodermal cells have been sloughed from russeted apple so that protective tissue consists of a corky remnant. (Fig. 5)

Livestock-Feed Surpluses Increase Faster Than Meat Production in the St. Louis Trade Territory



EMER E. BROADBENT and ROYCE A. HINTON

THE FLOW of livestock from farms in the St. Louis trade territory could almost double if all the surplus feed produced in this territory were fed locally.

The territory includes 49 Illinois counties as well as 62 counties in Missouri. The livestock feed-meat balance in the area has been affected by changes in meat consumption, in feed and livestock production, and in the marketing structure. A recent study concentrated on changes between 1939 and 1959. The trends for that period are indicative of the present situation in the territory.

Consumption and production

Meat consumption in the territory has greatly increased. From 1939 to 1959, consumption of red meat increased by nearly 50 percent, while poultry consumption more than doubled. Part of this rise was due to a 19-percent increase in population (Table 1). Most of it, however, was due to a rise in per capita consumption.

If population continues to increase as it has, there will be over 4 million people in the St. Louis trade area by 1969. And if per capita consumption also keeps rising, the demand for meat will be even greater than population figures would indicate.

Meat production has increased faster than consumption. Between 1939 and 1959, total production of red meat increased by 77 percent. In the Illinois part of the trade territory production increased 83 percent, while in the Missouri part it increased 70 percent. The greatest increase was in pork: There were 473 million more pounds in 1959 than in 1939 — an increase of 91 percent. Beef increased 289 million pounds (68 percent). The increase in poultry production amounted to 26 million pounds (46 percent).

Beef production increased uniformly throughout the trade area. Pork production, however, increased 101 percent in the Illinois part of the territory, but only 77 percent in the Missouri part. Poultry production actually decreased by 15 percent in Illinois while increasing 96 percent in Missouri.

Although total volume of livestock is sizable and is increasing, production is widely dispersed and in fairly small concentrations. In 1959, about 40 cattle and calves, 200 hogs, and 15 sheep and lambs were marketed for every 1,000 acres. Greatest livestock concentrations and greatest increases in marketings were in the northern part of the territory.

A significant portion of the beef, lamb, and mutton marketed was made up of imported feeder stock. Only a small amount of the pork originated outside the area.

The surplus of red carcass meat in the territory was over a billion pounds in 1959. This was more than twice as much as was needed for all consumers in the territory and more than the total 1939 production. The Illinois part of the territory contributed 698 million pounds of carcass meat to the surplus while the Missouri part supplied 440 million pounds. Nearly 85 percent of the total surplus was made up of pork.

A tremendous surplus of grain and protein feed is produced in the territory. The amount of surplus was calculated from the production of major feeds and the amount of feed required for livestock on hand.

The corn surplus more than tripled from 1939, when it was about 44 million bushels, to 1959, when it was over 144 million. In 1939 surplus production of high-protein feed supplements was about 280,000 tons; by 1959 it was 1,693,000 tons. These supplements consisted of soybean meal, meat scraps and tankage, and cottonseed meal and cake.

The increase in corn production was due mainly to greater yields per acre. While acreage increased 21 percent between 1939 and 1959, total production increased by 74 percent. Soybean production increased mainly because of an extraordinary increase in acreage — 423 percent.

A 13.6-percent decrease in hay production was more than offset by increased silage production. Production and use of grain silage increased despite unharvested hay and pasture crops.

Between 1939 and 1959, total acreage pastured decreased from about 15.8 million acres to 10.4 million acres. Unharvested or unused pasture represents the true feed surplus.

Emer E. Broadbent is Professor of Livestock Marketing and Royce A. Hinton is Assistant Professor of Farm Management.

Trends in marketing

Numbers of livestock handled by St. Louis terminals are decreasing. The major livestock market for the trade territory has been the National Stock Yards Company, near East St. Louis. It is commonly referred to as the St. Louis terminal livestock market. During the past 20 or 25 years, however, the packing industry has been initiating direct farm-to-packer marketing throughout much of the area. Many small auctions and local country markets, as well as a few large ones, now intercept much of the livestock that formerly moved to the terminal markets.

Between 1939 and 1959, while total marketings of cattle and calves increased by 87 percent, salable receipts at the St. Louis terminals decreased 8 percent. Hog marketings increased 87 percent; salable receipts, only 50 percent. Sheep and lamb marketings decreased 42 percent; salable receipts, 58 percent.

Despite declining receipts, the terminal markets supplied 70 percent of the total slaughter cattle bought by St. Louis area packers in 1963. The terminals also supplied 43 percent of the calves, 35 percent of the hogs, and 46 percent of the sheep. The packers bought 14 percent of their cattle, 17 percent of their calves, 50 percent of their hogs, and 50 percent of their sheep and lambs from auctions and local markets in the territory. The rest of their purchases (16 percent of the slaughter cattle, 41 percent of the calves, 15 percent of the hogs, and 25 percent of the sheep and lambs) were made outside the territory.

Packers in the territory sell most of their meat outside the area. This includes about 75 percent of their beef, 73 percent of their veal, 77 percent of their pork, and 80 percent of their lamb and mutton.

Chain stores in the territory import much of their beef from outside the territory. As the result of a 1963 survey, it was estimated that the chain stores sold over 200 million pounds of beef, of which they imported about 40 percent. Choice carcass beef was the most important kind imported.

Despite the surplus of beef in the territory, there is still a gap between supply of choice beef and demand. To meet the demand for quality beef, chain stores must get their supplies from packers west and north of the St. Louis trade territory.

Most fresh pork products were supplied to the chains by local packers, although some processed sausage products, bacon, and canned hams originated outside the trade territory.

Choices for the meat industry

The livestock and feed industry in the territory is now confronted with a basic problem: Should it produce more meat both for local consumption and export, or should it continue to export surplus feed?

The swine industry already supplies nearly all local needs and is still able to export two-thirds of its production. Is it feasible to build up the beef industry to the same point?

Obviously, producers are not going to feed grain to livestock if they think they can make more by selling it for cash, even if it moves outside the trade territory. On the other hand, livestock producers must produce and market more high-quality beef at lower prices if they are to become important suppliers of beef even in their own area. The livestock industry in the St. Louis trade territory will expand only as producers and marketing agencies do a better job than their competitors outside the territory.

Table 1. — Meat Requirements of the Trade Territory[a]

	1939	1949	1959	1969 projected[b] 15% increase	1969 projected[b] 20% increase
			(millions)		
Population	3.1	3.2	3.7	4.3	4.5
Beef, lb.	170.5	207.6	302.0	390.7	407.6
Veal, lb.	23.7	28.9	21.2	22.2	23.2
Lamb and mutton, lb.	20.6	13.3	17.8	19.2	20.0
Pork, lb.	201.7	219.9	251.0	277.5	289.6
Total red meat, lb.	416.5	469.7	592.2	709.6	740.4
Lard, lb.	39.6	38.3	32.7	31.2	32.5
Total red meat and lard, lb.	456.1	508.1	624.8	740.8	773.0
Poultry, lb.	51.7	74.4	130.7	166.1	173.3

[a] Calculated by multiplying population times U.S. average rates of consumption per capita as reported by USDA.
[b] Assuming U.S. meat consumption per person equal to 1963 rate.

Table 2. — Livestock Feed Balance for the Trade Territory

Feed[a]	Feed consumption requirements: Cattle, calves	Hogs	Sheep, lambs	Poultry	Horses, mules	Total	Production	Surplus
	(1,000 bushels or tons[b])							
1939								
Silage	507		25			532	534	
Corn	25,323	62,680	1,493	38,038	8,075	135,609	179,919	44,310
Oats	13,430				8,075	21,505	32,856	11,351
Protein	106	156	3	199		464	507	280
Roughages	6,568	196	1,199		3,445	11,408		
1959								
Silage	1,660		11			1,671	1,676	
Corn	34,754	109,625	709	22,823	1,007	168,920	313,354	144,433
Oats	9,990				1,007	10,997	18,043	7,046
Protein	127	378	1	133		639	2,332	1,693
Roughages	7,572	292	522		430	8,816		

[a] Silage includes corn and sorghum silage. Protein supplements include only proteins given as supplements, such as commercial protein supplements, soybean meal, meat scraps, urea, etc. (protein content of grains, silage, hay, and pastures is excluded). Roughages include hay and pastures.
[b] Measures: Silage in tons, corn and oats in bushels, protein supplements in tons of 44 percent protein content, and hay and pasture in tons of hay equivalents.

CONCRETE WALL PANELS That Are Self-Supporting and Extend From Footing to Roof

J. O. CURTIS and E. L. HANSEN

During the past year the Department of Agricultural Engineering has designed a new kind of reinforced concrete wall panel. It has been load-tested and used to construct a swine research building.

The panel extends from the footing of the building to the roof line (Fig. 1). To make the panel self-supporting, the lower edge is placed in a notch in the footing and the panel is anchored to the edge of the floor slab.

An earlier panel described in Illinois Research (Spring, 1965) was designed to be bolted down to a foundation wall. The new footing-to-roof panel has two main advantages over the bolt-down panel. First, since the panel rests directly on the footing, a separate foundation wall is not necessary. Second, the insulation in the panel may be extended below the floor slab to provide excellent slab edge insulation.

Three different panel types or configurations have been developed.

Type I consists of 3½ inches of reinforced concrete and 2 inches of polystyrene insulation. It is intended for use where an insulated wall and an inside wall surface other than concrete are desired.

Type II is a sandwich panel with two 1¾-inch thick concrete faces and a 2-inch polystyrene center core. It is planned for use where an insulated wall is required and where concrete faces are suitable for both interior and exterior wall surfaces.

Type III is a solid concrete panel 3½ inches thick, to be used in open buildings or in other buildings where insulated walls are not needed.

J. O. Curtis is Associate Professor and E. L. Hansen, Professor, of Agricultural Engineering.

Preliminary designs and tests

Concrete wall panels, like other structural members, must be designed to resist the loads to which they may be subjected. Such loads include the normal wind, snow, and dead loads plus erection loads. The lateral loads caused by wind and the erection loads were the critical ones in designing the panels.

The panels were designed in accordance with standards 318-63 and 525-63 of the American Concrete Institute, insofar as they were applicable. Ultimate strength design procedures were employed. Compressive strength of the concrete was 4,000 p.s.i., and yield strength of the steel reinforcement was 40,000 p.s.i. Only the reinforced concrete portions of the panel were assumed to be effective in resisting applied loads. That is, no credit was given for any composite action between the concrete and polystyrene portions of the panels.

Following preliminary design, two test panels were fabricated and load-tested. This was done to check experimentally the strength of the panels and the adequacy of the footing and floor anchorage system. In general the panels and the support system performed about as had been predicted analytically.

Final designs

On the basis of analytical studies and load tests, final designs were prepared for the three types of panels. Each type was designed to be 4 feet wide and to have three possible heights — 8, 10, and 12 feet.

The main details of a Type I panel are shown in Figure 2. The vertical steel should be in the center of the concrete portion of the panel. How much steel is needed varies, of course, with the height of the panel. The numbers and sizes of deformed steel reinforcing bars required for various wall heights are as follows:

Height of wall, ft.	*Number of steel bars* #3 *bars*	#4 *bars*
8	5	3
10	8	4
12	11	6

The horizontal reinforcement should be #3 steel bars. They should generally be spaced about 24 inches apart except that one bar should be 3 inches below the top of the panel, one should be 2 inches above the base of the panel, and one should be where the panel is joined to the floor. Two anchors are required at floor level and two in the top of the panel for lifting. They should be located about 12 inches on each side of the panel centerline.

Details of a Type II panel are shown in Figure 3. The number of deformed steel reinforcing bars in each concrete face is given below.

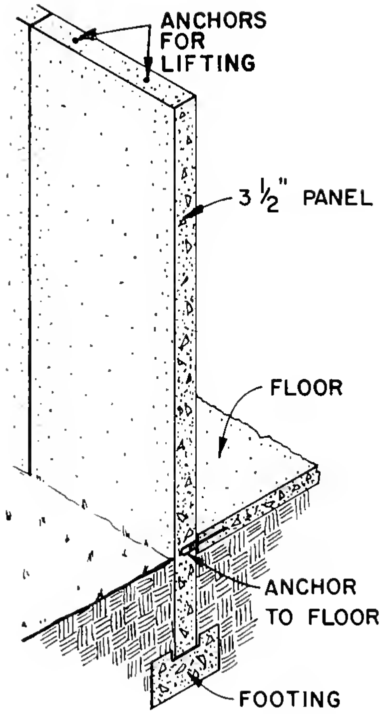
Height of wall, ft.	*Number of* #3 *bars*
8	6
10	8
12	11

Horizontal reinforcing steel should be #3 bars spaced as for a Type I panel. Anchors at floor level and in the top of the panel are also required as for Type I panels.

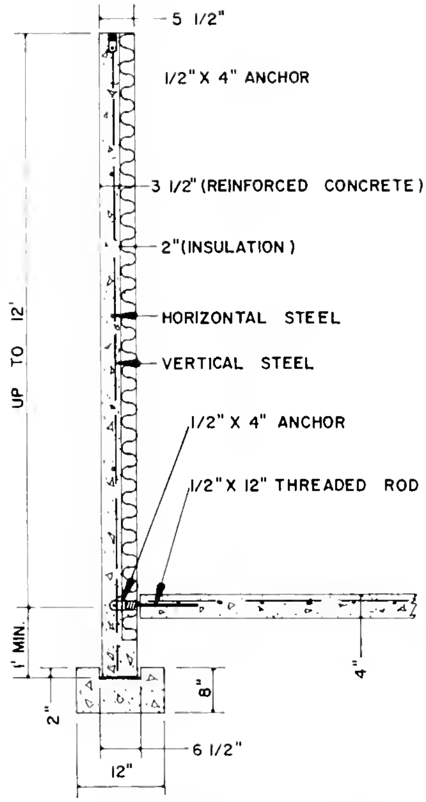
In a Type III panel (Fig. 4) the vertical reinforcement again varies with wall height. The required sizes and numbers of deformed steel reinforcing bars are as follows:

Height of wall, ft.	*Number of steel bars* #3 *bars*	#4 *bars*
8	7	4
10	11	6
12	14	8

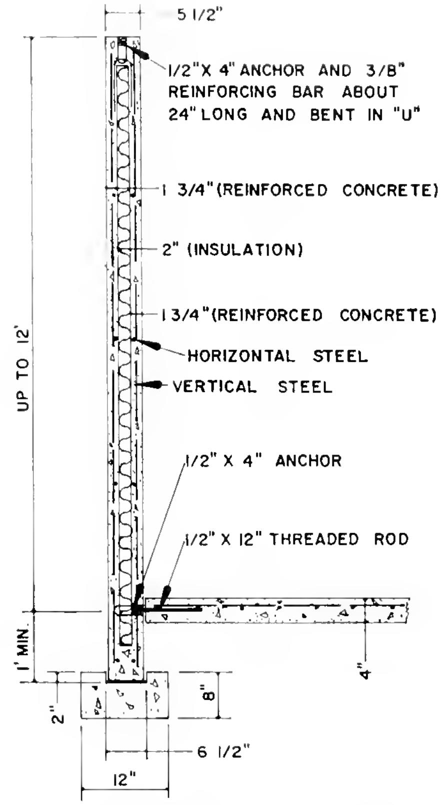
The spacing of horizontal reinforcing steel #3 bars and the placing of anchors are the same as for a Type I panel.



General plan of the footing-to-roof concrete wall panel. **(Fig. 1)**



Details of Type I panel. (Fig. 2)



Details of Type II panel. (Fig. 3)

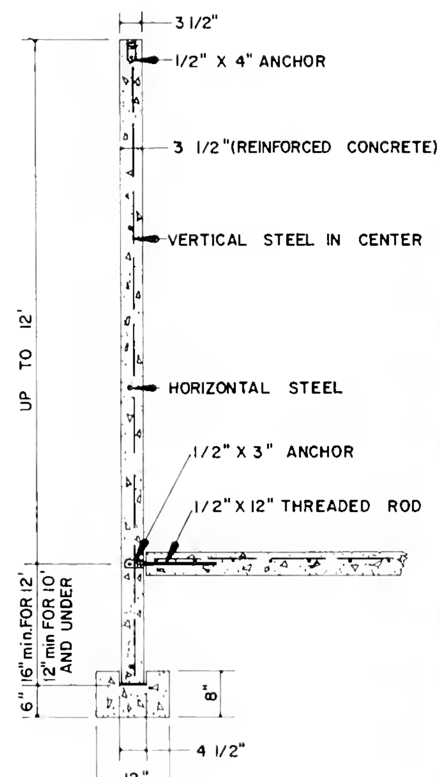
Construction experience

Type II panels have been used to build a 32-by-36-foot swine research building on a University farm. Panels were cast two at a time on a special casting bed near the building site. They were strong enough to be removed from the casting bed after about 24 hours, but they had to cure for about 7 days before being put into position in the building.

A special hoist was developed to raise the panels from the casting bed, move them to the building site, and lower them into position. The hoist was attached to the three-point linkage of a large farm tractor (Fig. 5). No major problem was encountered in casting and erecting the panels.

More detailed information

More detailed information is available in the booklet, "Footing-to-Roof, Self-Anchored, Continuously Insulated Concrete Wall Panels." To obtain this publication, write to the Department of Agricultural Engineering, University of Illinois, Urbana, Illinois 61801.



Details of Type III panel. (Fig. 4)

Panel being lowered into position on the footing. (Fig. 5)

Liquid Hog Manure Can Be Deodorized By Treatment With Chlorine or Lime

D. L. DAY

CHLORINE AND LIME have been tried during the past year in a continuing effort to find the best way of deodorizing liquid hog manure.

As untreated liquid manure is collected in pits and gutters beneath self-cleaning slotted floors, it immediately becomes anaerobic — that is, oxygen is used up. In this state, it supports anaerobic bacteria that produce objectionable gases and odors. Chlorine prevents bacterial action because it is a potent oxidizing agent and disinfectant. Lime raises the pH above the 6.8-to-8.0 range that is favorable for bacterial action.

Chlorine or lime was mixed with enough water to cover the bottoms of the pits beneath totally slotted floors. More chemicals were added as required until the pits were full. A pump with a flow rate of about 100 gallons per minute was used to circulate the pit contents as treating materials were added. When the pits were full, the same pump was used to remove the treated manure to sand drying beds that drained into a manure lagoon.

The sand was 6 inches deep over a gravel fill that contained drainage pipe and a sampling pump. Size of the beds was such that the waste material was about 4 inches deep on the beds while pumping was going on.

Tests with chlorine

Organic matter has a chlorine demand that must be satisfied before any residual chlorine will build up. The chlorine demand of swine waste was measured by using raw excreta and typical liquid manure. These limited tests showed an average demand of 0.1 pound of available chlorine per 100-pound pig per day.

Two forms of chlorine were tried separately, each with varying application rates and procedures. The two types of chlorine were powdered calcium hypochlorite, $Ca(OCl)_2$, which had 70 percent available chlorine; and liquid sodium hypochlorite, $NaOCl$, containing 15 percent available chlorine.

One run consisted of treating a pair of pits with sodium hypochlorite for 9 days, at the rate of three times a week. Slightly more chlorine was added, 30.6 pounds, than the estimated chlorine demand of 28.8 pounds. Characteristics of the treated manure before and after going through the sandbed are given below.

	Before	*After*
pH	7.2	6.9
Chemical oxygen demand (COD), p.p.m.	9,750	4,650
Biochemical oxygen demand (BOD), p.p.m.	3,350	1,918
Total solids, p.p.m.	10,330	9,700
Volatile solids, pct. of total solids	51.5	47.8

The dried crust remaining on the sand was analyzed for fertilizer value and was found to contain 2.36 percent of nitrogen, 1.4 percent of phosphorus, and 0.25 percent of potassium, on a weight basis.

Test with lime

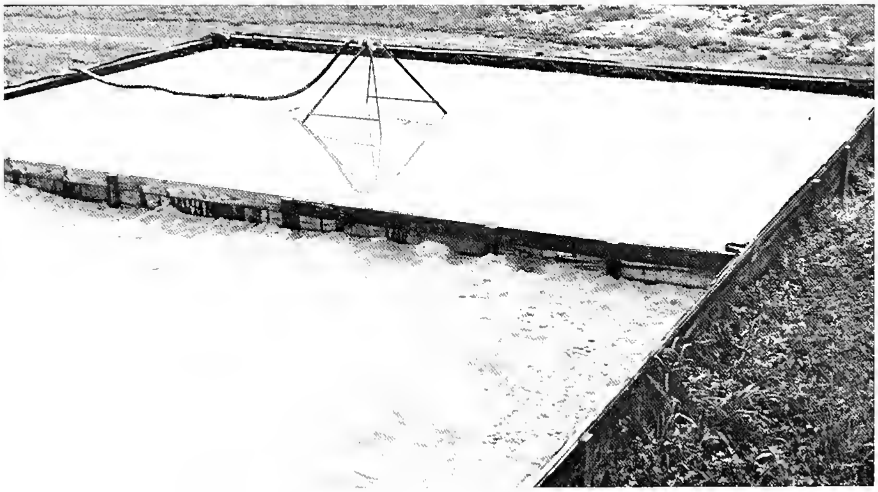
Enough hydrated lime, diluted in water, was added to pits to raise the pH of the manure to 11 and thus inactivate the anaerobic bacteria. When the pH dropped to 9, more lime was added. To maintain a pH of about 11 required 0.16 pound of lime per 100-pound pig per day.

Some general results

The treatments were effective in suppressing odors. In all tests, the sandbed filter reduced the BOD and COD by about 50 percent, indicating that about half of the organic matter in the treated manure was held on the sand. The effluent water could thus possibly be used again as pit dilution water.

The solids collected on the bed did not have an objectionable odor even after it rained. Rat-tailed maggots, prevalent in untreated pits, were not found either in the treated pits or in the solids on the sandbed. Dead rodents were noticed in and around the pits and sandbed.

The minimum chlorine treatment tried, which supplied less than half of the chlorine demand requirement, cost about $2.60 per hog for 6 months. Enough chlorine to fill the chlorine demand was estimated to cost $6.40 per hog for 6 months. The lime was much cheaper, costing about 62 cents per hog for 6 months when applied at the rate of 0.16 pound per 100-pound hog per day.



Chlorinated liquid manure pumped onto sandbed filter.

D. L. Day is Assistant Professor of Agricultural Engineering.

More Specialization for County Extension Staff

J. B. CLAAR

GREATER SPECIALIZATION is one way in which the Cooperative Extension Service is planning to meet the problems of the future.

The need for specialization by the Extension staff is readily apparent when we consider the diversity of problems relating to agriculture and home economics in a typical Illinois community. Moreover, the knowledge available in every subject-matter area is becoming more sophisticated. No longer is it possible for one person to maintain high competence in all the fields in which Cooperative Extension conducts programs. The public will thus be better served if the subject-matter scope of each staff member's assignment is limited.

Work across county lines

Under the new program, farm and home advisers will develop subject-matter specialties in keeping with their abilities and previous training, and then will work across county lines to give more people access to their specialized knowledge. A home adviser in one county, for example, may have done advanced work in financial planning and management. The home adviser in an adjoining county may have specialized in nutrition. The two can trade lessons, each using her special training for the benefit of women in both counties.

Such arrangements obviously require multi-county planning. For some highly specialized programs, people from three or four counties may come to a common meeting place. This will enable the Extension Service to mount a larger program than would be possible otherwise, and to teach at the depth required in our specializing society. Another advantage of a multi-county program is that many problems relating to community betterment and economic growth do not stop at county lines, but must be attacked by several counties working together.

With the help of county Extension councils, cooperative programs between counties have been tried experimentally for several years to make sure they would work. Series of lectures and workshops, for example, have been conducted on a multi-county basis. The numbers of people participating have indicated a real need for these programs. At present 58 staff members have specialized assignments which call for teaching outside their counties. Some staff members have no county assignment at all, but are assigned to a multi-county unit.

The need for continuing and expanding multi-county programs was underscored this spring by a committee of 17 staff members who had made an intensive study of the experimental programs. Their conclusion was that "the highest level of local program efficiency can best be developed on a multi-county educational service basis."

The expansion of multi-county programs is expected to increase the effectiveness of county offices. These will continue to be the focal point of program building in a given county.

To provide for multi-county programing and a systematic exchange of staff, the state will be divided into educational service areas that encompass several counties. Staff members who have no county assignments will reside in area centers.

Overall objectives

Underlying multi-county programing, as well as the other changes inaugurated by Extension, are six major objectives, which sum up the modern mission of the Cooperative Extension Service:

1. To develop an efficient and adequate agricultural industry. Through Cooperative Extension, farmers and people engaged in other agricultural businesses receive scientific information that stems from research and instructional programs of the University. The growth of agricultural industry, the increasing needs for output, the greater specialization of the industry, changes in business form, and changes in the marketing of agricultural products, all combine to create the greatest educational challenge to Extension and research in the history of the College of Agriculture.

2. To improve the quality of life by conducting programs relating to family living and homeowner problems. The experience of Cooperative Extension has clearly indicated that the family can be strengthened as a unit if each family member receives scientific information that enables and motivates him to perform his role well.

3. To provide leadership for youth programs by developing projects and events and by training volunteer leaders. These programs help young people gain knowledge and experience that will prepare them to earn their livings and to live full and useful lives.

4. To function as a center of leadership and educational assistance in aiding people at the community or area level to identify problems, inventory resources, and plan courses of action for community improvement.

5. To help provide an opportunity for people to continue their education in agriculture, home economics, and related subjects and to develop their leadership abilities. Formal education rapidly becomes obsolete, and continued study throughout life is necessary to keep up-to-date.

6. To assist the overall programs of the University of Illinois by providing a local office where people can contact the University to make full use of its resources and services.

J. B. Claar is Director of the Cooperative Extension Service and Associate Dean of the College of Agriculture.

RESEARCH IN BRIEF

What Happens When Rural Young People Look for Work in the Cities?

Since many rural young people go to the cities every year to find jobs, it is important to know what happens to them. Recently the State of Missouri Division of Employment Security published a study of job-seeking young people in St. Louis. This study was used as the basis for an Illinois Experiment Station analysis of the records of 3,558 young people, 18 to 21, who had migrated into St. Louis from more than 50 miles away.

Although these 3,558 young people did not all have strictly rural backgrounds, nearly all did come from nonmetropolitan areas. Most of them (60 percent) were male. Only 9 percent had more than a high school education; another 49 percent had finished high school. About half had a "general" education; 29 percent had received vocational and commercial training. When these young people registered with the employment service, only 8 percent were interested in what might be considered higher order occupations.

The outstanding pattern apparent among these young job applicants was their failure to follow through on their applications. Although 93 percent were referred to jobs, 87 percent of these did not respond. Many could not be reached within a week or two after their initial application. Apparently a large percentage had come to stay with relatives while hunting a job and had returned home when they did not get work right away. Only 7 percent were known to have found jobs on their own, although a few who found jobs independently may have been included among the large number who did not respond to job referral notices.

For a number of reasons, 83 percent were not tested by the employment service. It was assumed that aptitude testing was not necessary for the type of job to which some applicants were referred. Other applicants had been tested before they came to St. Louis. Overcrowded testing facilities caused some tests to be postponed. Many applicants could not be reached to set up an appointment for later testing.

This survey underlines the fact that more preparatory work should be done in local communities in orienting rural youth as to what to expect when looking for jobs in the city. They also need to have enough money so they can live in the city long enough to get the counseling, guidance, and job referrals available from the employment services. Careful follow-up work needs to be done to help these young people adjust to city life and work. These steps are becoming increasingly important as more and more rural youth migrate to the cities and as more and more jobs demand training beyond high school. — *D. E. Lindstrom*

Delayed Hypersensitivity Is Measured in Guinea Pigs

Delayed hypersensitivity is a manifestation of immunity which is of considerable interest to immunologists. The best known reaction of this type is the tuberculin skin test.

Delayed hypersensitivity is not accompanied by antibodies in the blood serum, so these cannot be used for measuring the degree of immunity. However, if living cells from hypersensitive animals are injected into normal animals, the latter will become temporarily hypersensitive.

In a recent study, a method was devised which makes it possible to measure the degree of hypersensitivity of guinea pigs immunized with diphtheria toxoid. A cellular exudate was induced in the peritoneal cavity of the immune guinea pigs by injection of mineral oil. The guinea pigs were then sacrificed and the cells recovered from their peritoneal exudate. The cells were counted under a microscope and various numbers of cells were injected intradermally into normal guinea pigs.

A few hours later, the normal guinea pigs received an intravenous injection of the antigen, diphtheria toxoid. A reaction similar to the positive tuberculin test appeared at the sites where hypersensitive cells had been injected. The minimal number of cells required to elicit the skin reaction in normal guinea pigs gave a measure of the hypersensitivity of the animals from which the cells were derived. — *D. Segre and J. B. Sharp*

Chinese Chestnut Is Found Susceptible to Oak Wilt Disease in Northern Illinois

In 1954 an experiment was begun at Sinnissippi Forest, Ogle County, to test the susceptibility of Chinese chestnut (*Castanea mollissima*) to oak wilt disease (*Ceratocystis fagacearum*).

Fifty seedlings were obtained from the U.S. Plant Introduction Garden and were planted in an active pocket of oak wilt disease in a mixed oak timber type. Half the seedlings were a year old when planted; half, 2 years old. They were spaced 12 feet apart.

In 1957, oak wilt disappeared from the oaks in the immediate area of the chestnut plantings. Active oak wilt remains throughout the forest, however, although it is kept under control on an annual basis (see Ill. Agr. Exp. Sta. Bul. 680). The last oak wilt close to the chestnuts was found in 1960 in an 11-inch red oak growing about 50 feet away from the chestnut plot.

In 1965 it was noted that some of the chestnut trees had died back the previous year, although they were vigorously sprouting. New wilt was also noted during the 1965 season. Samples of twigs and rootstock were

sent to Dr. Eugene B. Himelock, plant pathologist, Illinois Natural History Survey, for analysis. Oak wilt disease was identified in two root samples and one twig sample, which came from three separate trees. At present 21 healthy chestnut trees remain in the planting.

Many years ago American chestnut (*Castanea dentata*) was planted for landscape purposes in several towns in Ogle County. No sign of chestnut blight (*Endothia parasitica*) appeared in any of these trees until 1964. That year the blight was noticed in a group of trees in the northwest part of Oregon. The Chinese chestnuts in Sinnissippi Forest have been examined closely for chestnut blight, but it has not been found in this stand to date. — *H. W. Fox*

Vitamin C in Rations of Young Pullets Does Not Improve Shell Formation

Until recently it has been assumed that vitamin C (ascorbic acid) is not essential in poultry rations. Some recent research has indicated that vitamin C may be required to maintain eggshell quality in older pullets, especially when they are exposed to high temperatures. Many researchers, however, have reported no such effect.

In humans and guinea pigs, which do require vitamin C, it has been shown that high air temperatures and diets rich in protein deplete the vitamin reserves in the body. Vitamin C has also been shown to increase calcium absorption through the intestinal wall and to stimulate the formation of collagen, a fibrous protein. In chickens, collagen is the framework around which calcium is deposited to form an eggshell. Thus it seemed that vitamin C should improve eggshells when pullets were fed diets low in calcium and high in protein while temperatures were high.

This hypothesis was explored by subjecting young laying pullets to the following treatments in all possible combinations: vitamin C — 0 and .025 percent of diet; calcium — 1.0, 2.5, and 4.0 percent of diet; protein — 15, 25, and 35 percent of diet; temperature — 70° F. and 87° F.

Contrary to expectations, vitamin C had an adverse effect on shell formation in pullets fed the highest protein diets under high temperatures at all levels of calcium in the diet. Vitamin C had little or no effect at the lower temperatures.

These results suggest that it may not be possible to project our concepts of vitamin C nutrition in humans and guinea pigs to chickens. They also indicate that we lack information for making the broad recommendation that vitamin C should be added to laying rations. — *D. J. Bray and D. J. Morrissey*

Is Continuous Cropping Practical for Soybeans?

With the rapidly increasing acreage of soybeans in the Corn Belt comes the question, "Is it practical to grow this crop year after year on the same land?"

A test to help answer this question has been in progress since 1954 at the Hartsburg Agronomy Research Field in Logan County. Average soybean yields during the past 12 years (1954-1965) have been 33.4 bushels per acre with continuous cropping and 33.6 bushels per acre on adjacent land in a three-year rotation of corn, soybeans, and wheat with a legume catch crop. In 1965 the continuous beans yielded 41.5 bushels.

The same soybean varieties, planting dates, and tillage methods were used in each cropping system with plots duplicated in random arrangement. All plots have been limed and receive phosphate and potash each year. Treatments with different amounts of nitrogen have had no significant effect on soybean yields in either cropping system. The soil type is Sable silty clay loam.

Plant diseases, insect problems, and other cultural difficulties tend to cumulate with continuous cropping and may eventually do so in this experiment. However, to date no observable problems have developed during 12 years of continuous soybeans. — *L. B. Miller*

Production by Virus-Infected Cell Cultures of Factors Affecting Cellular Morphology

Virus-cell interaction in tissue culture may kill the cells or alter cellular morphology. On the other hand, such interaction may have no visible effects on the cells.

The mechanisms by which viruses kill cells or alter their structure are not known. Nor is it clear why certain viruses propagate in cell cultures without visibly affecting them. However, substances that are toxic to cells or tissues have been found in certain virus-cell systems. It appears possible that such cytotoxins may be at least partly responsible for the cellular damage resulting from viral infection.

In the present investigations, cytotoxins were found in cell cultures infected either with fully active hog cholera virus or with Newcastle disease virus inactivated with ultraviolet irradiation. The cytotoxins had the unique characteristic of being activated if they were acidified and then neutralized. Without such treatment, the materials recovered from virus-infected cultures did not affect test cultures.

The results suggest that the virus-infected cultures produce both a cytotoxin and a substance which inhibits the activity of the cytotoxin. Acidification would destroy the cytotoxin inhibitor, thus permitting activity of the cytotoxin. Both ultraviolet-inactivated Newcastle disease virus and active hog cholera virus fail to alter cell cultures. This situation may be an effect of the production, by virus-infected cells, of the postulated cytotoxin inhibitor. Conversely, viruses which kill their host cells during the course of their propagation may induce the formation of a cytotoxin, but not a cytotoxin inhibitor.

Although the significance of cytotoxins in the pathogenesis of virus-induced cellular alterations remains unclear, the results suggest a possible avenue for the investigation of virus-cell interactions. — *D. Segre, A. El-Zein, and W. L. Myers*

FARM BUSINESS TRENDS

The business of producing milk has been meeting strong competition, especially in Illinois. While some dairy farms have been profitable and expanding, many farmers have dropped the dairy enterprise.

Growing corn and soybeans for sale produces far more per hour of labor than dairying. Farmers who have enough cropland have little need for the additional income that can be obtained from a sideline dairy enterprise.

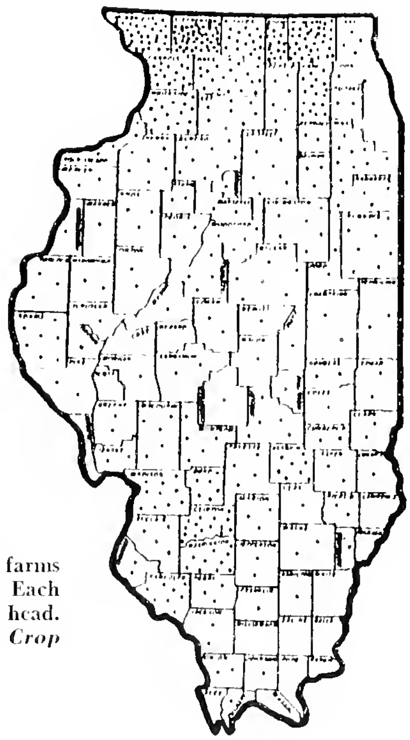
Many farmers have found pork production more profitable than dairying. Cattle feeding isn't any more profitable than dairying, but the beef business is less confining and more glamorous. Off-farm employment is also more attractive than dairying to many men, both farm operators and hired workers.

In some other states, such as Wisconsin, Minnesota, and New York, alternatives to dairying are not so attractive.

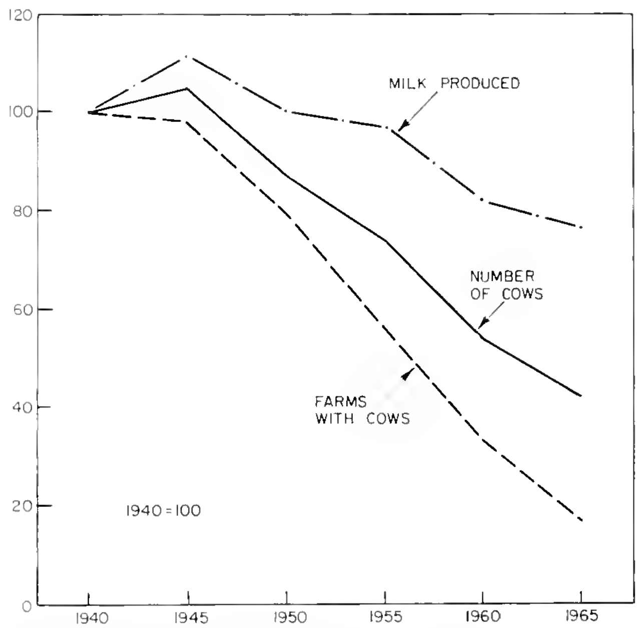
In Illinois dairying competes best along the northern border and in a few counties east of St. Louis (see map).

Illinois milk production in 1965 was 3,987 million pounds. This was 31 percent below the all-time high of 1945, when the state's dairymen produced 5,777 million pounds of milk. Illinois's percentage of the nation's total production was at its highest — 5 percent — in 1934. By 1965 it was only 3.2 percent.

Farmers of the state received about $148 million from the sale of milk in 1965. This amount was 2.9 percent of the total received by all U.S. dairymen, and it represented 5.8 percent of all cash receipts from farming in our state. — *L. H. Simerl*



Milk cows on Illinois farms as of January 1, 1966. Each dot stands for 1,000 head. *(Map from Illinois Crop Reporting Service.)*



Changes in milk production, numbers of cows, and numbers of farms with cows, Illinois, 1940-1965.

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IN THIS ISSUE

This drawing of an old magnolia hybrid first appeared in *Curtis's Botanical Magazine* in 1820. The hybrid is now being re-created in a more winter-hardy form (page 8).

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ILLINOIS

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CONTENTS

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M. B. Russell . . . . Director

Adrian Janes . . . . Station Editor

Margery E. Suhre. . . . Editor, ILLINOIS RESEARCH

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NEWS AND VIEWS

Transforming Facts into Food

New technology arising from research is a powerful catalyst of economic growth. In no sector of our national economy has this fact been demonstrated more dramatically than in agriculture.

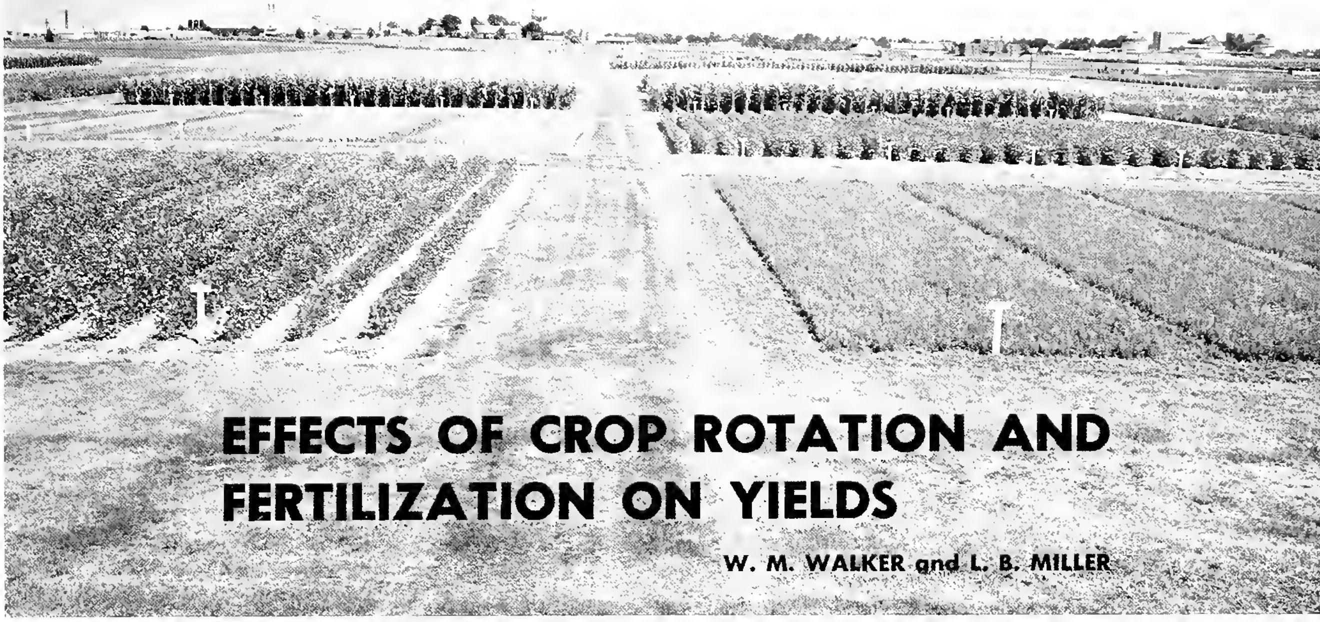
Since the end of World War II, the support of research by public funds has expanded rapidly and is now a major factor in shaping the size and nature of the work being done in all major branches of science. The rationale for the expenditure of public funds for research is that the value of the benefits which accrue to society from such work far exceeds the tax funds that are used to support it.

When new knowledge gained from basic studies in the natural sciences is transformed into new products or techniques useful to man, the process is commonly called applied research. This is the vital link between the discovery of a new bit of basic information and the exploitation of that knowledge to fulfill a human need. New knowledge rarely, if ever, can be used in isolation to achieve technological advance. Instead, each new bit of information must be fitted into the complex body of existing facts. The new data interact with the old, usually in a highly interdependent way.

Agricultural phenomena are characterized by a high order of interaction between many physical, biological, and socio-economic factors. New information on cellular physiology, for example, can be used to improve the efficiency of milk production only after extensive study of the interaction between the new information and the existing technologies involved in managing a dairy herd.

At a time when there is growing awareness of the need to expand sharply the world's food-production capacity and when new breakthroughs in the basic sciences are occurring at a rapid rate, it is imperative that greater efforts be made in such fields of applied science as agriculture. More emphasis must be given to the rapid transformation of new knowledge from the basic sciences into workable technologies that will enable a hungry world to feed itself.

Unfortunately, the growing needs and opportunities in applied agricultural research have not been matched by a corresponding increase in funds or in personnel. Efforts must be increased to attract into such work more of our ablest and most imaginative young scientists, if the growing body of new information from the basic sciences is to be fully utilized to help feed a hungry world. — *M. B. Russell*



EFFECTS OF CROP ROTATION AND FERTILIZATION ON YIELDS

W. M. WALKER and L. B. MILLER

Without soil treatment, corn and soybeans yield much better in a four-year rotation than in a two-year rotation; with soil treatment, the difference between the rotations is very small

HOW DOES a crop rotation system affect crop yields? And how does the rotation modify the effects of fertilizers?

These were two of the questions being considered when an experiment was initiated at the Agronomy Farm in Urbana in 1947. Specifically, the objective was to determine the effects of five fertility treatments and two crop rotations upon the yield of crops in the rotation.

Fertility treatments consisted of LKrP, LKN, LKNrP, and LKNsP, plus an untreated check. (L represents lime; rP, rock phosphate; sP, superphosphate; K, potash; and N, nitrogen.) The two rotations were a four-year rotation of corn, soybeans, wheat, and hay; and a two-year rotation of corn and soybeans.

For 10 years before the study began, the experimental area had been cropped continuously with corn without any fertilizer. The soil, Proctor silt loam, was very low in available phosphorus.

W. M. Walker is Assistant Professor of Agronomy and L. B. Miller, Assistant Professor of Soil Fertility.

Amounts of soil additions

Nitrogen. For the two-year rotation, 125 pounds of ammonium nitrate per acre was applied to the corn crop until 1952, when the acre rate was increased to 360 pounds.

For the four-year rotation, the annual rate of ammonium nitrate on corn was 125 pounds per acre until 1964, when it was increased to 240 pounds per acre. In addition, 60 pounds of ammonium nitrate was applied on wheat in the spring.

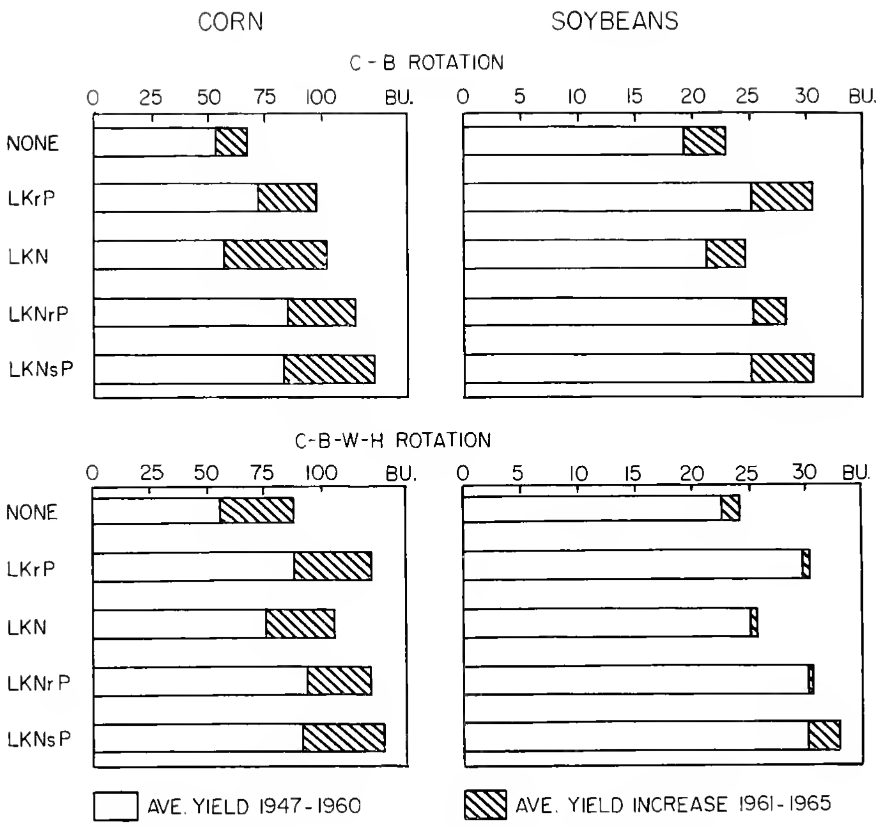
Limestone and potassium. Every plot except the check plots received 4 tons per acre of agricultural limestone in 1947 and again in 1957. Potash was applied biennially at a rate of 100 pounds of K_2O (83 pounds of potassium) per acre.

Phosphorus. The superphosphate plots received phosphorus every other year, or whenever corn or wheat was grown. The rate was 40 pounds of P_2O_5 (18 pounds of phosphorus) per acre until 1962, when the rate was increased to 60 pounds. Rock phosphate plots received 1,600 pounds per acre in 1947 and 1,200 pounds in 1960.

Corn yields

On every plot, including the check plots, average corn yields were consistently higher in 1961-1965 than in 1947-1960 (see chart on next page). This was probably due to the improved cropping practices which have been adopted in recent years. Specifically, higher rates of nitrogen, higher plant populations, and better adapted varieties were probably responsible for the general increase in yields on the experimental plots.

Plots receiving phosphate fertilizer yielded significantly more than plots that did not receive phosphate. For the entire period of the study there was no statistically significant difference between rock phosphate and superphosphate as a source of phosphorus for corn. However, for the 1961-1965 period, corn yields were consistently higher from the superphosphate plots. During those five years, corn yields from these plots averaged 125 to 130 bushels per acre, suggesting that for high yield levels it may be desirable to supplement rock phosphate with superphosphate.



Corn and soybean yields in two rotations and with five fertility treatments.

Nitrogen fertilizer increased corn yields in the two-year rotation. It is possible that increased amounts of nitrogen in this rotation would have produced higher yields.

Nitrogen had no significant effect on yields in the four-year rotation. This indicates that under the conditions of this study, with corn grown once every four years, the legume provides all the nitrogen requirements of the corn. The data do not, however, necessarily indicate that corn following a legume never needs nitrogen. According to other experiments, when corn is grown oftener than one-fourth of the time, yields are frequently increased by nitrogen fertilizer in addition to a legume.

Without any fertilizer, corn yields were appreciably higher in the four-year rotation than in the two-year rotation. With the LKNsP treatment, however, yields were almost as high in the two-year rotation as in the four-year rotation. This suggests that the fertilizer is partially substituting for the beneficial effects of the four-year cropping system.

Soybeans

Since soybeans are a leguminous crop, they did not receive a direct application of nitrogen fertilizer. Any effect of nitrogen on soybeans would have had to be residual; however, no significant effect was noted.

From 1947 to 1960, applications of either rock phosphate or superphosphate increased soybean yields by about 4 bushels per acre in both crop rotations. Since 1961, superphosphate has had a slightly greater effect, but the difference is not significant.

For the 1947-1960 period soybean yields in the four-year rotation averaged about 4 bushels per acre higher than those in the two-year rotation. During the past five years, however, yields from the two rotations did not differ significantly. This may be due to the increased level of fertilizer applied in the 1961-1965 period.

Wheat and hay

Average wheat and hay yields obtained during the first 14 years of the study and those obtained in recent years are given in the table. Both nitrogen and phosphorus significantly increased wheat yields. The response to phosphate fertilizer was especially dramatic, since the soil phosphate supply was very low and since wheat is sensitive to low phosphate levels.

As has been demonstrated in previous experiments, superphosphate was significantly better than rock phosphate as a source of phosphorus for wheat. These results confirm that wheat needs a more soluble source of phosphorus than rock phosphate.

Improvement in wheat yields in the 1961-1965 period, as compared to earlier years, may have been largely due to improved varieties and growing conditions. Part of the increased yields on the LKNsP plots is probably due to the increased level of superphosphate used since 1962.

Alfalfa and red clover were seeded in the wheat in the spring. Response of the meadow or hay crop was similar to that of the other crops, in that all fertilized plots yielded better than the check plots.

In some seasons, however, hay stands were poor on the high-yielding wheat plots because of competition from the wheat. Under these conditions, fertilizer did not increase hay yields as much as would normally be expected. This is one explanation for the differences in hay yields between the LKNrP and LKNsP plots in recent years as compared with the differences in the earlier years of the study.

Wheat and Hay Yields for Two Time Periods and Five Fertilizer Treatments

Fertilizer	1947–1960		1961–1965	
	Wheat, bu./A.	Hay, T./A.	Wheat, bu./A.	Hay, T./A.
O	13.2	1.68	14.6	1.75
LKrP	27.2	3.22	34.9	3.56
LKN	19.5	2.53	27.8	2.77
LKNrP	28.1	3.13	37.3	3.80
LKNsP	34.5	3.12	52.0	3.18

Relationship of age and stage of lactation to MASTITIS IN DAIRY COWS

In 20 herds, 23 percent of cows in their first lactation produced CMT-positive milk, as compared with 75 percent of the cows in their sixth lactation

G. W. MEYERHOLZ and L. R. FRYMAN

THE OLDER the cow, the more likely she is to have mastitis. At least this was recently found to be true in 20 southeastern Illinois Grade A dairy herds. The same finding has also been reported in previous studies.

A survey of the 20 herds, including 509 cows, was made in October and November, 1964. Its purpose was to determine the relationship between mastitis in one or more quarters and both the age of the cow and the stage of lactation.

How survey was conducted

We visited each herd at morning or evening milking time. Just before the milking machine was attached, the milk from each quarter was given the California Mastitis Test (CMT), as developed by O. W. Schalm and D. O. Noorlander. A reading of 2 or 3 on the CMT was considered positive for mastitis; a reading below 2 was considered negative.

Herd records were used to establish the age of each cow and the date of last calving. From these records and other information supplied by the dairymen, we determined both the number of lactations and the stage of lactation for each cow.

Housing of cows

One of the herds was housed and milked in a stanchion barn. The others were milked in elevated milking parlors. Of these, 18 herds were housed in conventional loose housing sheds and one was kept in a free stall barn during the winter.

Significant differences due to age

Of the 509 cows, 47 percent produced CMT-positive milk from one or more quarters. Positive test results were found in a higher percentage of the older cows than of the younger cows (Table 1). Only about 23 percent of the cows in their first lactation produced CMT-positive milk. This percentage gradually increased until it was over 75 for cows in their sixth lactation. The differences are even more significant when we consider that many older cows had already been culled because of mastitis.

Of the 130 cows in their first lactation, 88 were in their first five months of lactation at the time of the test. Of these, 14 (16 percent) had positive test results, as compared with 16 (38 percent) of the 42 that had been milking six or more months.

Stage of lactation

In Table 2 the percentages of CMT-positive cows are given according to stage of lactation. Although the differences are probably insignificant, the percentages of cows producing positive milk were smaller for the first three months of lactation than for the later stages. This difference may be partly due to the large number of first-calf heifers in early lactation included in the survey.

Occasionally cows in very early or very late stages of lactation produce milk with high leukocyte counts that give positive CMT results although these cows may not necessarily have mastitis. In this study, however, the percentage of cows giving positive milk was no greater in late lactation than from the fourth month on. Occasionally milk from all four quarters of late-lactating cows showed trace or low CMT reactions — too low to be considered positive. Since most of the cows in late lactation were producing well, the concentration of leukocyte cells in their milk remained low. Neither early- nor late-lactating cows in this study had high enough leukocyte counts to represent a practical problem.

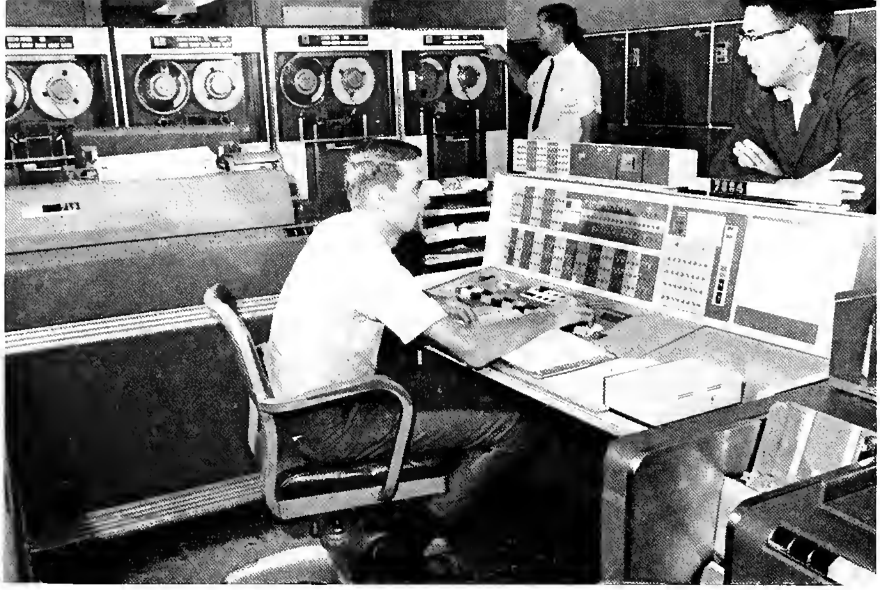
Table 1. — Percent of Cows in Different Age Groups Giving CMT-Positive Milk

Lactation	Total cows	Cows producing CMT-positive milk	
		Number	Percent
First	130	30	23.1
Second	117	57	47.0
Third	103	45	43.7
Fourth	53	34	64.2
Fifth	44	31	70.5
Sixth	29	22	75.9
Seventh or more	33	22	66.7

Table 2. — Percent of Cows in Different Stages of Lactation Giving CMT-Positive Milk

Month of lactation	Total cows	Cows producing CMT-positive milk	
		Number	Percent
First	83	29	34.9
Second	85	35	41.2
Third	60	25	41.7
Fourth	36	20	55.6
Fifth	22	13	59.1
Sixth	24	13	54.2
Seventh	36	22	61.1
Eighth	54	28	51.9
Ninth	45	22	48.9
Tenth or more	64	34	53.1

G. W. Meyerholz is Assistant Professor of Veterinary Pathology and Hygiene and of Veterinary Extension; L. R. Fryman is Associate Professor of Dairy Science Extension.



S. G. Carmer, Associate Professor of Biometry, Department of Agronomy, with two members of the IBM 7094 computer operation staff, wait as the computer solves a problem in agronomy. Information for solving the problem has been placed on one of the magnetic tape units (left background). The central processing unit (right background) performs the arithmetic while an operator sits at the console (foreground). Solution to the problem will be placed on another of the magnetic tapes.

USE OF ELECTRONIC COMPUTERS Greatly Expands Agronomic Research

S. G. CARMER

In less than a minute high-speed electronic computers can solve problems that would take several days, or even several weeks, with hand methods of calculation. The computers thus provide a means of improving the amount, quality, and timeliness of information disseminated by the Agricultural Experiment Station.

In the Agronomy Department, computers have been used for processing research data since 1954. That year several hundred individual sets of data from agronomic experiments were analyzed on Illiac I (Illinois Automatic Computer), a computer designed and built by scientists and engineers at the University of Illinois.

During the intervening years computers with greatly expanded capabilities have become available. Last year over 7,500 sets of agronomic data were processed by an IBM 7094 computer housed in the Department of Computer Science. Computers are widely accepted by the Agronomy Department as a means of increasing the productivity of research. In fact, their use is essential for many research projects.

Computer recipes

Before a computer can process data, or solve any other kind of problem, it must be instructed what to do. The instructions are stored in the computer's memory where they are ready to be obeyed at extremely high speeds. The memory can also hold large quantities of data which are available for high-speed calculations under the direction of the instructions. Intermediate results of calculations are stored in the memory as well, and may be utilized by subsequent instructions. To complete the picture, devices are provided for getting information (instructions and data) into the computer and getting answers out.

A set of instructions that the computer obeys in solving a problem is called a program. Essentially, a program is nothing more than a very detailed recipe written in a language suitable for entry into the computer. Since the computer follows its recipe exactly, the answers will be correct only if the recipe is correct.

A program's life cycle

To assure a correct computer program, an orderly, logical development is necessary. Creating a program requires time and effort, the amounts varying with the complexity of the problem. There are four major steps in developing a usable program.

Planning phase. During this initial stage the problem is studied and analyzed. The problem must be defined in very specific terms before a program can be written to solve it. Once the problem is defined, questions about the prospective program need to be answered. These include questions such as the following:

1. Shall the program be written to handle just this one specific problem, or to handle a whole class of similar problems which differ only in certain details? Usually some generality is built into a program so that it can be used for more than one problem.

2. How shall the computations be performed? Quite often computing "tricks," which are not suitable for pencil and paper calculations, are more amenable for computer usage than are the usual methods of calculation.

3. What information (data) must be put into the computer, and how shall it be put in?

4. What information (results) is to be put out by the computer, and how shall it be put out?

When these questions have been answered, the program logic is developed, and block diagrams or flow charts are prepared to illustrate the steps to be followed by the computer in solving the problem.

Coding phase. As a contractor follows the architect's blueprints for

building a house, the programmer follows the flow charts in the actual writing or coding of the program. The basic machine language "understood" by most computers is based on the binary number system, which consists of only two digits, zero and one. To simplify the writing of programs, special programming languages such as FORTRAN, which are easier for a programmer to use than completely computer-oriented languages, have been developed. Programs are usually first written out on paper coding sheets and then punched onto cards.

Testing phase. During this phase the new program is "run" on the computer, using problems with known answers, to locate any errors in the program. Such errors may be classified as clerical, coding, or logical. The first type are typographical errors occurring when the program is punched onto cards. Coding errors result when a programmer misinterprets the flow charts, much as a builder may occasionally misread a blueprint. Logic errors result from faulty thinking and are the hardest to detect, perhaps because people do not like to admit they make mistakes.

Production phase. After the program has been thoroughly checked out and is free of errors, it is ready for use in solving the problems for which it was developed. It may be used over and over again for problems within its capabilities.

Agronomy program library

The Agronomy Statistical Laboratory maintains a library of over 60 programs for use on the University's IBM 7094 computer. While these programs have been developed to process data for the agronomy staff, they are also used by persons in many other departments and divisions of the University. The programs fall into the following three categories:

Randomization of experimental layouts. To assure that the results of statistical analysis will be valid, the treatments being studied in an experiment must be allotted at random (within the restrictions imposed by the experimental design) to the field plots available for the study. Randomization is not particularly difficult, but it is time-consuming if done by hand for a very large number of experiments.

Computer programs are used to generate the randomized experimental layout; the printed results are then used by the research staff as a field plan in planting the field plots and conducting the experiment. Treatment codes for each plot are punched out on a deck of cards; data subsequently collected from the experiment are punched onto this deck in preparation for computer analysis.

Preliminary processing of data. After data have been punched onto cards, a listing of the data is made and compared with the original data records. The purpose is to find and correct any errors made in transferring the data to cards.

Often, for the sake of convenience, data from small experimental plots are converted to units other than those in which they were originally recorded. In small grain trials, for example, yield data are recorded in pounds or grams per plot, but the research worker wants to report yield in bushels per acre. The necessary calculations are done with programs for the preliminary processing of data.

Analysis of data. Depending on the nature and purpose of the experiment, the data may be subjected to one or more types of analysis. The most common ones are analysis of variance, multivariate analysis, and correlation and regression analyses. With these techniques, the mass of observations are reduced to a few well-chosen statistics, capable of interpretation; and the precision of the results can also be estimated.

Other computer applications

In addition to library programs, special programs are often developed to handle large but non-recurring problems. A few examples are given below of problems which could not have been handled without computers.

Soil inventory. Several years ago Soil Conservation Service personnel, in cooperation with the Agronomy Department, compiled data on almost 100,000 soil sampling units throughout the state. These data have been transferred to magnetic tape, and special programs have been written to summarize them. One result of the programs will be computer-printed tables summarizing slope-erosion classes for each soil type for every county. These tables will later be included in an Experiment Station publication.

Sequential sampling plans. Certification of seed requires that the seed production fields pass rigid inspections for quality. To facilitate inspection, the computer has been used to develop sequential sampling plans for inspectors to follow. Since allowable tolerances differ, depending on the particular impurity, plans have been developed for a number of different tolerances.

Simulated experiments. Sometimes it is impractical or impossible to perform actual experiments to solve a problem. In such a situation, it may be possible to construct a mathematical model for the problem. By use of the computer theoretical results can be obtained for various values of the variables and parameters in the model. These techniques are being used, for example, to study the equations of water flow through soils. Another example of their use is to simulate results after many generations in a breeding program.

Research can be expanded

The high speed of electronic computers permits the handling of problems which would otherwise not be attempted. More complex analyses can be made and more different kinds of data from a given research project can be analyzed with savings in money as well as time. These savings free the researcher to make more meaningful interpretations of results, plan new experiments further extending the limits of knowledge, and communicate his findings to his colleagues and to the public.

A New-Old Magnolia Hybrid

A hybrid dating from the early nineteenth century has been re-created in a form that will survive Illinois winters

J. C. McDANIEL

An old magnolia hybrid has been re-created to give Illinois home owners a sweet-scented flowering ornamental that will survive cold winter weather.

M. virginiana is one parent

One parent of this hybrid is *Magnolia virginiana* L. or Sweet Bay magnolia, sometimes called *M. glauca*. It is a variable species, growing as either a shrub or tree and having white to creamy-colored flowers. Of the seven native magnolia species in the United States, *M. virginiana* is apparently the most common. It grows naturally from east Texas and southern Florida to northern Massachusetts, being especially abundant in boggy soils near the Atlantic and gulf coasts.

In the Midwest, *M. virginiana* is not planted nearly as frequently as some of the earlier flowering Asian species and hybrids with similar site requirements. It can be grown through most of Illinois, however, and has some advantages to offset the spectacular, early-spring burst of bloom of the deservedly popular Asian cultivars. It has a later and longer flowering season — from May into July — which is seldom spoiled by spring freezes. Its fragrance is among the finest of the genus. And even when it is not in flower, it has superior landscape beauty with its silvery white underside leaf color, its red fruits, and its graceful smooth gray branches that appear to good advantage whether or not there are leaves on the tree.

The mainly deciduous northern variety (*M. v.* var. *virginiana*) is the Sweet Bay most frequently cultivated in Illinois. It generally varies from a multistemmed large shrub to a small tree.

This variety is typically smooth-twigged, but some forms in eastern North Carolina have pubescent or fuzzy twigs. These forms have previously been mistaken for the southern variety (*M. v.* var. *australis* Sargent), which is characteristically pubescent-twigged.

The southern variety is the prevailing one near the southern coasts, and occurs inland to Tennessee. It is best distinguished by its lemon-like flower scent and by its pale pollen, as compared with the butter-yellow pollen of the northern variety. Some trees of the southern variety are almost or entirely evergreen. A number of these evergreen forms are adapted to central Illinois, although they do not occur naturally north of Tennessee.

In its best stream-side southern locations, the southern variety often becomes a large tree, as tall as 70 feet or more and up to 3 feet in trunk diameter. Shrubby, slow-growing forms, however, grow in some areas near the southern coasts. Several of these shrubby clones, collected in Jasper County, Texas, in late 1965, have so far remained consistently slow-growing in good soil at Urbana, but they await the hardiness test of subzero weather.

M. tripetala is other parent

The hybrid's second parent is *M. tripetala* L., a small, smooth-twigged tree. Its leaves grow to 2 feet long, giving it its popular name of umbrella magnolia. It is one of the hardier American species, ranging farther north inland (Pennsylvania and Ohio) than any other species except *M. acuminata* L., which goes into Canada along the north shore of Lake Erie. *M. tripetala* ranges westward into Oklahoma and southward into the lower gulf coastal plain, but not as far south as *M. v.* var. *australis*.

Rather ill-scented flowers are the main defect of *M. tripetala* as an ornamental tree. Its trunk is a frequent target for sapsuckers.

First hybrid a natural one

The oldest reported hybrid magnolia, known as *M.* × *Thompsoniana* (Loud.) C. de Vos, is generally believed to be a natural hybrid of *M. virginiana* and *M. tripetala*. As long ago as 1820, Dr. John Sims referred to it in *Curtis's Botanical Magazine* as "Thomson's New Swamp Magnolia." A Mr. Thompson (correct spelling), who was a nurseryman near London, had grown it from seeds collected on one of his Sweet Bay trees in 1808. Sims, not recognizing it as a hybrid, gave it the Latin varietal name *major*, as a large variety of the Sweet Bay species. Its present name was bestowed by C. de Vos in 1876. (Louden in 1838 had called the hybrid *M. glauca* var. *Thompsoniana*.)

This hybrid has sweet-scented flowers that are larger than those of *M. virginiana*. In its original form, however, it is not as winter-hardy in America as either parent species, and so is still rare in its ancestral land.

Although one clone of *M. virginiana* var. *australis* has stood the winters at Mt. Pulaski, Illinois, for many years, and another has survived the more rigorous winters (to −25° F.) at Brookville, Pennsylvania, plants of

J. C. McDaniel is Assistant Professor of Horticulture.

Flowers of the new M. × Thompsoniana hybrid. Note similarity to picture of original hybrid shown on cover.

the original *M.* × *Thompsoniana* have sometimes winter-killed in the milder climate around Philadelphia.

The reasons for the winter-tenderness of this first hybrid are not known. Possibly the *M. virginiana* ancestor, or both parents, derived from southern areas where they had not been subjected to very cold winters.

Hybrid generally sterile

The original hybrid has survived by vegetative methods of propagation. It seldom sets any seed and, as recently shown by Dr. Frank S. Santamour, Jr. (University of Pennsylvania), the pollen is nearly always sterile.

So far as I can ascertain, no second cultivar of this hybrid was found in the wild or entered horticultural propagation between 1820 and 1960. Thus the hybrid species was exclusively represented for perhaps more than 150 years by a single clone that was hardy enough in southern England and the warm coastal areas of the United States, but was not reliably winter-hardy in Philadelphia or colder areas.

New crosses made

With hardy flowering trees of both *M. v.* var. *virginiana* and *M. tripetala* growing in private yards in Urbana, there has been an opportunity to breed a new *M.* × *Thompsoniana* hybrid with more winter-hardiness than the original. Beginning in 1960, I have made reciprocal cross-pollinations whenever flowering of the two species has overlapped (*M. tripetala* is earlier).

Several hybrid seedlings have resulted from crosses in which various *M. virginiana* trees of the northern variety were the seed parents. But on three *M. tripetala* seed trees, cross-pollinations have resulted either in no seeds, or in seeds which reproduce the *M. tripetala* species. Crosses of *M. v.* var. *australis* × *M. tripetala* also have failed to yield hybrids.

Some of the new *M.* × *Thompsoniana* clones have been experimentally reproduced by cuttings under intermittent mist. They have been top-grafted by the chip-bud method onto stocks of both parental species. First flowering occurred in 1965, with a hybrid grafted on a branch of *M. tripetala*. This clone and another one, also grafted on the *M. tripetala* stock, flowered in May and June, 1966, after a May 10 freeze had killed most of the new foliage and flower buds of *M. tripetala* trees at Urbana.

The two clones that have flowered thus far have minor foliage and flower differences. Both, however, like the original English clone, have sweetly scented flowers, larger than those of *M. v.* var. *virginiana*, but smaller than those of *M. tripetala*. Leaves and stems are also intermediate in size.

Like most *M. virginiana* flowers of either variety, the flowers of the hybrids produced here have each had three well-differentiated sepals and eight white petals. (*M. tripetala* and the other American magnolias commonly have either six or nine petals although eight-petaled flowers are occasionally produced.)

The hybrids resemble *M. tripetala* in that their flowers open for the first time late in the day, around 6 p.m. *M. v.* var. *virginiana* opens earlier, but *M. v.* var. *australis* is also a late afternoon opener. All close again during the night, and open again on the second day to shed pollen.

The new *M.* × *Thompsoniana* seedlings have been tested outside at Urbana, and, with the aid of cooperators, southward to Oak Ridge, Tennessee. All of the seedlings have been fully winter-hardy, as is *M. tripetala* here. Two were even hardier than *M. tripetala* against an unseasonable May freeze, because their flower buds developed later and had not reached so sensitive a stage.

One or more selections from among these seedlings may soon become available, permitting residents of northern climates to grow a distinctive type of ornamental, fragrant-flowered small tree not hitherto hardy where temperatures go to −15° F.

STAIN-REPELLENT FABRICS:

How to remove stains; how to retain and repair the repellent finish

RUTH LEGG GALBRAITH
and JANET IZARD

With fluorochemically finished fabrics, stain removal is not the chore that it used to be — provided you give the fabric proper care. The following recommendations for care are based on the research reported on these two pages:

- **Keep finishes repaired** by pressing. Wherever a finish becomes very worn, press the worn area and then spray it with a fluorochemical finish.
- **Clean fabrics** before they get very dirty or severely stained.
- **Remove stains** by working undiluted, heavy-duty liquid detergent into the stain with flexing and rubbing. Scrubbing flat is not as effective as flexing, but will be necessary on upholstery fabrics. Rinse with rubbing and reapply detergent as necessary.
- **We do not recommend** extensive home use of a grease solvent such as carbon tetrachloride. However, dry cleaning will give you the benefits of a solvent.
- **Whenever a severe stain** has had to be removed from the fabric, repair the finish with pressing and a fluorochemical spray before using the article again.

EVERY NEW development in textiles brings a new set of problems to be solved. A frequent and worrisome problem is that of removing stains from clothing, table linens, carpets, and upholstery.

Such fibers as nylon or the polyesters (Dacron, Fortrel, Kodel, and Vycron) increase a fabric's resistance to water-borne stains and make it dry quickly; but these fibers also have a very high attraction for oil-borne stains. If oily stains remain in nylon or polyester fibers for any length of time, they are extremely difficult, if not impossible, to remove.

The development of the fluorochemical finishes, such as Scotchgard and Zepel, which are both water- and oil-repellent, was a tremendous aid in preventing stains. However, in a previous study (see *Illinois Research*, Summer, 1965), it was found that laundry and wear could fracture the film of finish surrounding the individual fibers. The fabrics then lost part of their oil repellence although they retained most of their water repellence. Pressing the fabrics healed the fractures enough to improve oil repellence but not to restore it to the point where there was no fabric staining at all.

Ruth Legg Galbraith is Professor of Textiles; Janet Izard was formerly Assistant in Home Economics. This article is based on a Master's thesis done by Miss Izard under Dr. Galbraith's direction.

Since these worn fabrics still repelled water while retaining oil, it was theoretically probable that conventional laundering would not remove oil stains. A study was therefore begun with a threefold purpose:

1. To determine the extent of the stain-removal problem on fluorochemically finished fabrics.

2. To develop, if possible, better methods of repairing the fractured finish.

3. To find some method of removing oily stains from a damaged finish.

One repair method we particularly wanted to investigate was the use of aerosol spray cans containing a fluorochemical finish for home treatment of clothing and household fabrics. These sprays have appeared on the retail market within the past year. They are of two types (in different colored cans) — one for washable fabrics and one for nonwashable fabrics.

Three fabrics "damaged"

Three plain-weave fabrics with fluorochemical finishes were selected for the study. Two were 100 percent cotton with a wrinkle-resistant finish. The third was 65 percent polyester and 35 percent cotton with a durable press finish.

Each fabric was cut into 75 squares, 5¼ inches wide. Of these, 15 were kept as original fabric specimens without damage to the finish. The other 60 were tumble-abraded in an Accelerotor for 1 minute (#250 grit liner, 3,000 r.p.m.). They were then machine-basted onto sheets. This was necessary to insure adequate agitation of the small specimens when they were laundered.

The laundering was done in a top-loading automatic washer set on normal cycle, with a hot wash and warm rinse. The total load of 7 pounds was made up with other pieces of sheeting. One cup of controlled-suds, heavy-duty detergent was used. After laundering, the specimens and sheets were tumble-dried for 40 minutes at moderate temperature (130°-175° F. exhaust temperature).

Three repair treatments

After drying, the squares were removed from the sheets and 15 of them were retained as examples of a damaged finish which had not been repaired. The other 45 were divided into three groups of 15 specimens each, to be given three different repair treatments: (1) pressing with a steam iron; (2) spraying with a fluorochemical aerosol spray; and (3) both pressing and spraying.

The spray designed for washable fabrics was used, according to directions on the can. Before any experimental specimens were sprayed, a reproducible spraying technique was developed by spraying onto glass,

where the spray pattern could be seen and checked.

Two kinds of stains

Each of the specimens, including the 15 original fabric specimens, was then cut into four smaller squares. These squares were stained with 0.1 c.c. of either the vegetable oil from a nonemulsified French dressing, or bacon fat at a temperature of 170° F. The oil and fat were applied with a hypodermic needle.

After the stains had been on the fabric for 3 minutes, they were "wicked off" with tissues so that they wouldn't spread farther.

Stain-removal treatments

Stain-removal treatments were applied to half of the specimens within 8 hours. The other half were not treated until a week after they had been stained. There were 3 replicate specimens for every combination of stain, condition of fabric finish, kind of fabric, and time of treatment.

Four methods of stain removal were tried:

1. Conventional laundering, using procedures already described.

2. Sponging with carbon tetracloride. Before sponging, the samples were placed on an absorbent backing.

3. Hand scrubbing. A half teaspoon of a heavy-duty liquid detergent was placed directly on the dry stain, flexed and rubbed into the stain by hand, and rinsed out with repeated rubbing.

4. A hand scrubbing followed by treatment with carbon tetrachloride.

All treatments with carbon tetrachloride were performed in a hood which carried the fumes away from the experimenter. If too much carbon tetrachloride is inhaled, it can damage the liver.

Rating of specimens

After the stain-removal treatments, specimens were arranged in a random order for rating by a panel of five. The rating was done on a scale from 1 (severe staining) to 5 (no stain). A rating of 4.5-5 was considered to represent an acceptable appearance. Sample specimens showing the degree of staining for each rating level had been prepared as a guide for the panel.

The 15 ratings for each type of specimen (5 panel members × 3 replicate specimens) were averaged. In addition, grand averages were calculated to show specific effects for fabric type, type of repair, and type of removal treatment when all other variables were placed together.

Effects of Fabric Pretreatment, Stain Type, and Removal Treatment on the Oily Stain Ratings of Fluorochemically Finished Fabrics[a]

Fabric pretreatment	Stain removal treatment	Stain ratings[b]: Salad oil, Fresh	Salad oil, Aged	Bacon fat, Fresh	Bacon fat, Aged	Grand average
None	None	4.5	4.6	4.3	4.5	4.4
	Laundry	4.2	4.2	4.3	4.1	4.2
	CCl_4	4.9	4.9	4.8	4.9	4.9
	Scrub	4.8	4.7	4.7	4.7	4.7
	Scrub plus CCl_4	4.6	4.4	4.7	4.6	4.6
Damaged	None	1.1	1.1	1.0	1.1	1.1
	Laundry	2.5	2.6	2.9	2.9	2.7
	CCl_4	3.5	3.4	3.0	3.0	3.2
	Scrub	4.2	4.0	4.1	4.2	4.1
	Scrub plus CCl_4	4.6	4.3	4.7	4.6	4.6
Damaged and pressed	None	1.9	2.3	2.0	2.1	2.1
	Laundry	3.0	2.9	3.0	3.1	3.0
	CCl_4	4.2	4.0	3.6	3.6	3.9
	Scrub	4.6	4.2	4.3	4.5	4.4
	Scrub plus CCl_4	4.8	4.7	4.8	4.7	4.7
Damaged, pressed, and sprayed	None	4.6	4.5	3.8	3.B	4.2
	Laundry	4.2	4.1	3.3	3.2	3.7
	CCl_4	4.6	4.9	4.4	4.2	4.5
	Scrub	4.7	4.9	4.3	4.4	4.6
	Scrub plus CCl_4	4.9	4.8	4.9	4.7	4.8

[a] The values given are averages for all three fabrics.
[b] A 5.0 rating would represent no staining at all; a 1.0 rating, very severe staining.

Results of treatments

As in the earlier study, the original fabrics with no damage to the finish were quite repellent to both vegetable oil and animal fat stains. This is indicated by the ratings in the table for the specimens having no fabric pretreatment and no stain removal treatment.

Oil repellency was severely lowered when specimens were abraded and laundered but given no repair. Pressing increased the oil repellence slightly, but spraying with a fluorochemical (not shown in table), and the combination of pressing and spraying raised the repellence still more.

At the better levels of repair, the specimens repelled salad oil stains nearly as well as the original fabrics, but repelled bacon fat less well. Specimens sprayed without previous pressing were only slightly less repellent than those given the two-step treatment.

Specimens that had been stained and laundered were often worse looking than those that had received no stain-removal treatment, because the stains tended to spread during laundering. In general, scrubbing plus treatment with carbon tetrachloride removed stains most effectively, and scrubbing alone was nearly as good. Use of carbon tetrachloride alone was more effective than laundering, but less so than scrubbing.

Although the stains were extremely difficult to remove, aging for one week did not seem to make them any more difficult. Here again bacon fat was held more tightly than the salad oil. The fabric containing the polyester fiber and having a durable press finish consistently retained oil more tenaciously than the other two fabrics, so that stain-removal treatments rarely produced stain ratings over 4.5, which was the lowest acceptable rating.

Sources of Scotch Pine for Christmas Tree Plantations

Tree in foreground is a premium tree, unsheared.

J. J. JOKELA, L. B. CULVER, and C. A. STEWART

The pine tree has replaced the traditional "tannenbaum" or fir tree as the festive symbol of Christmas. The odds are 4 to 1 that the tree in your home or in the homes you will visit during this coming holiday season will be a pine, and 2 to 1 that it will be a Scotch pine. The popularity of Scotch pine has soared as the Christmas tree industry has shifted from wild to plantation-grown trees, and reflects a prevailing preference for a dense, full-bodied tree.

Scotch pine, or as it is more properly named, *Pinus sylvestris,* is a favorite of growers because of the ease with which it can be sheared to produce a desirable density and shape. It has become the mainstay of the Christmas tree industry; yet, because it is a highly variable species, it is a problem in American forestry.

A good timber tree

Scotch pine is the most widely distributed pine. It is native to Scotland and the northern latitudes and higher elevations of temperate Eurasia, where it is a prime timber tree. Over extensive areas it is the only commercially important pine. Introduced into North America in colonial times, it was used extensively for early reforestation.

In general, the performance of Scotch pine in American plantations has been disappointing. Even the "Riga" variety, famed for straightness of stem as a timber species, has often done poorly in this country. Scotch pine has outperformed native pine just often enough, however, to sustain a continuing interest in the species. Most early plantings are believed to be of northern European and possibly unsuitable origins.

Regional study of origins

The quest for suitable sources of Scotch pine for forestation of areas unsuited to native pines would perhaps have remained an academic one were it not for the skyrocketing popularity of Scotch pine Christmas trees. By 1960 Scotch pine had become the second most planted tree in the Lake States, and by 1965 the most planted tree in Illinois.

Spurred by the prospect that millions of the Scotch pine being planted annually would never be harvested for Christmas trees but would be allowed to develop into low-grade forests, the North Central Regional Tree Improvement Committee (NC-51) undertook a study in which the performance of Scotch pines was related to their origin.

Test plantings involving 186 seed sources from every part of the species's natural range were established in 1961 and 1962 in eight North Central and two other states. Three plantings, involving 106 sources ranging from Scotland to Siberia and from Spain and Turkey to northern Finland, were established in Illinois. These are at Sinnissippi Forest, Ogle County; Mason State Forest, Mason County; and the West Salem Experiment Field, Edwards County.

Screening and rating trees

During the fifth winter after planting, all trees in the three Illinois test plantings were rated, without regard to foliage color, as acceptable (U. S. No. 2 or Standard Grade or better) or unacceptable. The 36 sources with the greatest number of acceptable trees were selected for further screening. All or most of the sources from Spain, France, the Balkan States, and Russia (Georgia) were included and constituted three-fourths of the selections.

Half of the trees from these 36 sources in the Edwards and Ogle County plantings were rated according to the official U. S. standards for Christmas trees. But rigorous adherence to grade requirements downgrades trees for defects which shearing would eliminate. Grading was therefore supplemented with quality ratings as to the trees' worth had they had the benefit of shearing. These ratings were on a 9-point scale (1-3, cull; 4-6, salable; 7-9, good to excellent). The grade assigned to each tree was the consensus of three experienced graders. Ratings of the 12 most promising Christmas tree sources are summarized in Table 1.

Color, growth, and needle length

The foliage of Scotch pine Christmas trees often has an objectionable yellow color. Yellowing results when cold temperatures in the fall lessen the activity of the cells producing chlorophyll or green pigment. The farther north the seed origin, the greater the degree of yellowing.

During the first four winters after planting, foliage color was scored on a visual scale (1-3, extreme yellow to yellow-green; 4-6, yellow-green to dark green; 7-9, slightly blue-green to very blue-green). Color scores of the 12 selected sources in the fourth

J. J. Jakela is Assistant Professor of Forestry; L. B. Culver, Associate Professor of Forestry Extension; and C. A. Stewart, Research Assistant in Forestry.

Table 1. — Grade Distribution and Mean Quality Ratings, Fifth Winter After Planting, Selected Seed Sources, Ogle and Edwards County Plantations

MSFG No.[a]	Seed origin, locality and country	Location of planting, county	U. S. grade: Premium	No. 1	No. 2	Cull	Unrated[b]	Mean quality rating
			Percent of living trees					
218	Avila Pr., Spain (Gredos Mts.)	Edwards	27	40	7	13	13	6.0
		Ogle	18	23	41	18	0	5.4
219	Segovia Pr., Spain (Guadarrama Mts.)	Edwards	25	15	20	40	0	6.2
		Ogle	25	31	25	13	6	5.8
221	Ankara Pr., Turkey	Edwards	42	11	31	16	0	5.7
		Ogle	29	29	21	21	0	5.8
238	Auvergne, France	Edwards	36	14	14	36	0	5.7
		Ogle	4	44	17	31	4	5.2
239	Auvergne, France	Edwards	11	22	28	39	0	4.8
		Ogle	29	33	17	21	0	5.5
240	Pyrenees-Orientales, France	Edwards	67	11	11	6	5	6.2
		Ogle	38	29	25	8	0	6.3
242	Serbia, Yugoslavia (Tara Plateau)	Edwards	21	11	37	16	15	5.5
		Ogle	27	41	23	5	4	6.4
245	Segovia Pr., Spain (Guadarrama Mts.)	Edwards	38	24	9	24	5	6.3
		Ogle	25	29	21	13	12	6.2
246	Huesca Pr., Spain (Guara Mts.)	Edwards	22	28	17	28	5	5.7
		Ogle	47	27	13	0	13	6.6
247	Soria Pr., Spain	Edwards	32	21	11	26	10	5.8
		Ogle	25	10	35	5	25	6.0
264	Georgia, USSR (Caucasus Mts.)	Edwards	23	18	27	14	18	6.4
		Ogle	27	32	27	14	0	5.7
551	Serrai Pr., Greece	Edwards	5	27	36	32	0	5.6
		Ogle	27	41	18	14	0	6.8

[a] Michigan State University accession number. Detailed information on origin is available upon request.
[b] Too small or damaged.

Table 2. — Winter Foliage Color, Fourth Winter After Planting, Selected Sources (Average for Three Plantations)

MSFG No.	Color score: Yellow 1-3	Green 4	Green 5	Green 6	Blue-green 7	Blue-green 8	Blue-green 9	Mean color score	No. of trees
	Percent of living trees								
218	0	0	0	7	36	43	14	7.6	77
219	0	0	1	19	50	27	3	7.1	80
221	0	1	14	20	53	11	1	6.6	84
238	0	4	5	20	38	31	2	6.9	84
239	0	1	5	10	57	21	6	7.1	82
240	0	0	1	20	50	22	7	7.1	81
242	0	1	7	29	39	23	1	6.8	77
245	0	0	0	18	49	30	3	7.2	79
246	0	1	4	32	45	18	0	6.8	73
247	0	0	2	17	53	25	3	7.1	70
264	0	4	13	55	24	4	0	6.1	75
551	1	9	19	32	29	10	0	6.1	84

winter are summarized in Table 2. As shown in this table, some sources had a wider range in color than others. All 12, however, had satisfactory color for Christmas trees, although color had not been a factor in their selection.

The 12 selected sources are intermediate in growth rate and needle length between the short-needled, slowest growing, far-northern sources, and the fastest growing, long-needled Belgian and German sources. Mean fifth-year heights of the 12 sources

Table 3. — Mean Height of Trees After Fifth Year, Ogle and Edwards County Plantations

MSFG No.	Plantation: Edwards	Ogle
	ft.	*ft.*
218	3.4	3.6
219	3.4	3.5
221	3.6	4.2
238	3.5	4.0
239	3.4	4.7
240	2.8	3.3
242	3.8	4.9
245	3.0	3.4
246	2.7	3.2
247	2.9	3.4
264	3.3	4.2
551	3.6	4.4

are given in Table 3. In contrast to these heights, the sources from northern Finland and central Siberia averaged slightly better than 1 foot, and the sources from central Europe averaged about 6 feet in height.

Needle length was quite variable between plantations and years. The Balkan and Georgian sources tended to have slightly longer foliage than did the Spanish sources. Among the 12 sources, a Spanish source (246) consistently had the shortest needles and a source from Yugoslavia (242) had the longest needles in the three years that foliage was measured.

Southern sources best

Although data now available do not provide a reliable enough basis for selecting the best sources of Scotch pine for Illinois growers, they strongly suggest that the most suitable seed origins will be found along the southern limits of the species range.

Results of this study uphold the popular belief that Spanish trees are among the best, but more than that, they focus attention on equally promising trees of Balkan and southwest Asian origins. Many people might prefer the slightly longer, lively dark green foliage of these trees over the shorter, blue-green to gray-green foliage of Spanish trees. Furthermore, trees of Balkan and Georgian origin are somewhat more hardy in northern Illinois, and may develop into better timber trees.

Dairy Cows Develop Milk Fever When Extra Calcium Is Added to Ration

K. A. KENDALL, K. E. HARSHBARGER, R. L. HAYS, and E. E. ORMISTON

As research continues on milk fever (parturient paresis) in the dairy cow, we are accumulating evidence that the disease can be prevented by adequate feeding during the last 3 or 4 weeks of gestation. We are also learning more about the effects of both proper and improper feeding upon the composition of the blood serum.

Other studies raise questions

Our most recent studies grew out of questions raised by investigations at other institutions, both in this country and abroad. These studies have suggested that milk fever in aged cows can be greatly reduced by feeding lower levels of calcium in relation to phosphorus during the dry period. In some studies, when the ratio of calcium to phosphorus in the ration was as high as 6:1, the incidence of milk fever was much greater than when the calcium-to-phosphorus ratio was narrowed to 1:1. According to other investigators, the incidence of milk fever has been reduced by including 5 percent monosodium phosphate in the grain mixture fed during the dry period and throughout lactation.

In some of these studies the cows received inadequate levels of digestible energy during late gestation. Obviously the cows could not be prepared for maximum milk production in the next lacation.

Not only were the cows fed inadequate rations, but the observations made in the studies were not substantiated by enough blood analyses during the first 24 to 36 hours after calving. This period is an especially critical time, since milk fever symptoms are most likely to develop then.

Our questions, then, were these: Would a more complete, postpartum blood picture pinpoint the metabolic trends associated with inadequate feeding? Would such a picture help us to find borderline cases of milk fever? Specifically, how would the cow be affected at calving time if the calcium-to-phosphorus ratio were shifted in the pre-calving ration?

An experiment was set up to provide some answers. Cows were fed an adequate ration before calving, with some cows receiving extra amounts of calcium. Detailed studies were made of the blood composition during the first 36 hours after calving. The serum levels of calcium and phosphorus in normally fed cows were then compared with the levels in cows receiving extra calcium. Such comparisons provided a basis for distinguishing between typical milk fever and borderline cases of calcium or phosphorus deficiency. Typical milk fever cases are ordinarily characterized by a decline of 50 percent or more in serum calcium and often an even greater drop in serum inorganic phosphorus.

Rations fed

In previous studies with milk fever suspects (cows with histories of clinical milk fever), the cows were fed the University milking-herd grain mixture at the approximate rate of 1 pound per 100 pounds of body weight daily, plus alfalfa hay free choice, for about 3 weeks before the expected calving date. On this regimen, 92 percent of the milk fever suspects passed the post-calving period without developing the milk fever syndrome. This was verified by frequent serum mineral analyses throughout the 36-hour postpartum period.

The same feeding regimen was followed in the present study, which included eight Holsteins and two Jerseys, all aged cows without a previous history of milk fever. Five of the cows, three Holsteins and two Jerseys, were fed additional calcium in the form of feeding-grade limestone at the daily rate of 225 grams (about ½ pound) per cow.

Average daily grain intake for the 10 cows was 14.3 pounds; roughage intake, 13.5 pounds. The calculated daily intake of calcium and phosphorus and the ratio of calcium to phosphorus in the rations appear in Table 1.

Blood serum analyses

Blood samples were taken from the jugular vein for several days before calving and at frequent intervals during the first 24 to 36 hours after calving. The blood serum was analyzed for calcium and phosphorus using standard procedures.

Figure 1 shows the trends in the levels of blood-serum calcium and inorganic phosphorus when cows were fed the ration containing supplemental limestone. Of particular interest are the levels in cows 2009 (Jersey) and 1875 (Holstein), which were much lower than the levels in the other cows. Both of these cows developed milk fever and were treated at the times indicated in Figure 1. In general, the calcium and phosphorus levels in the cows fed the supplemented ration were much below those in cows receiving the unsupplemented ration (Figure 2).

K. A. Kendall, Professor of Dairy Science; K. E. Harshbarger, Professor of Nutrition; R. L. Hays, Associate Professor of Physiology; and E. E. Ormiston, Professor of Dairy Husbandry, are all in the Dairy Science Department.

Table 2 gives the lowest observed calcium level, with the accompanying inorganic phosphorus level and calcium-to-phosphorus ratio, for each group of cows. In the cows not receiving a calcium supplement, these values were all within normal limits. By contrast, the cows receiving supplemental calcium were abnormally low in serum calcium and inorganic phosphorus, and had a high calcium-to-phosphorus ratio.

In our other studies, when cows with milk fever histories were similarly fed but received no additional calcium, the average lowest observed serum calcium level was 7.3 milligrams per 100 milliliters and the accompanying phosphorus level was 3.2 milligrams per 100 milliliters. These values more nearly approach normal levels than those of the limestone-fed cows in the present study. This further suggests that cows late in gestation should not receive excessive amounts of calcium in relation to phosphorus.

Table 1. — Average Daily Intakes of Calcium and Phosphorus, and Ratio of Calcium to Phosphorus Fed

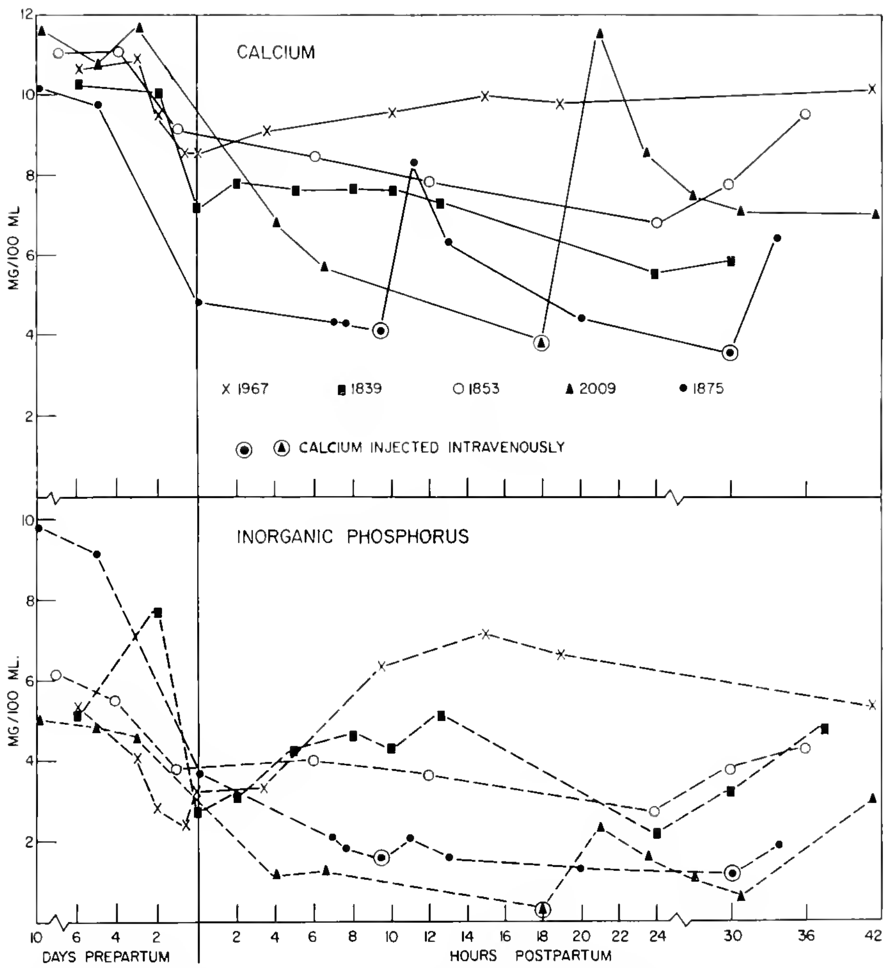
Mineral	Ration	
	Normal[a]	Extra calcium[b]
	intake	
Calcium, gm.	126.5	192.5
Phosphorus, gm.	54.8	46.9
Ca:P ratio	2.3:1	4.2:1

[a] Grain at 1 percent of body weight, plus alfalfa hay.
[b] Same ration as above, plus 225 grams of limestone. Two of the five cows on this ration developed milk fever.

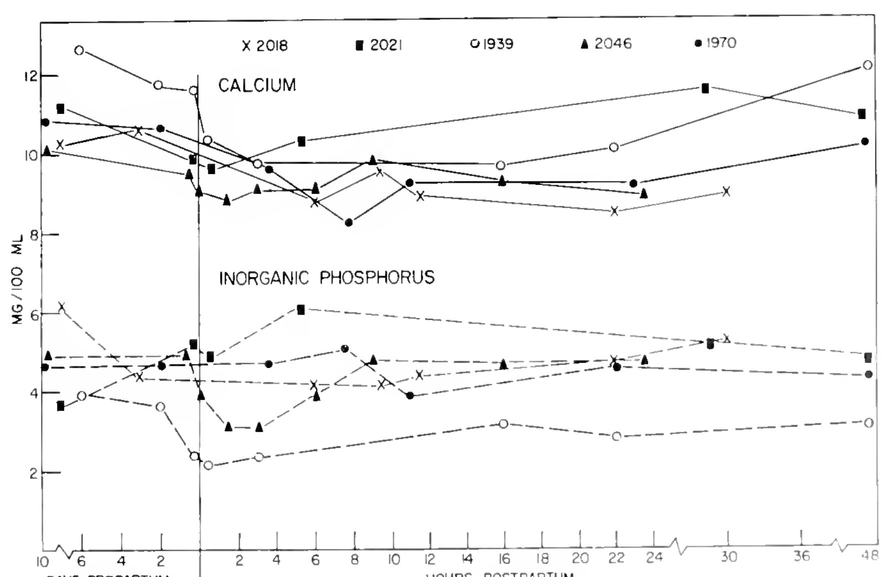
Table 2.—Average Lowest Observed Blood Serum Calcium Levels and Accompanying Inorganic Phosphorus Values, 24 to 36 Hours Postpartum

Mineral	Ration	
	Normal[a]	Extra calcium[a]
	serum levels	
Lowest observed calcium, mg./100 ml.	8.96	5.76
Inorganic phosphorus, mg./100 ml.	4.17	1.82
Ca:P ratio	2.15:1	3.16:1

[a] See footnotes for Table 1.



Blood serum levels in cows whose daily ration for about 3 weeks before calving consisted of the University milking-herd grain mixture at 1 percent of body weight, alfalfa hay free choice, and 225 grams of calcium carbonate (limestone). (Fig. 1)



Blood serum levels in cows that received the grain and alfalfa as in Figure 1, but not the limestone. (Fig. 2)

Taxes for recreation facilities?

JOSEPH J. JOPEK, JR.

Yes, say the majority of residents interviewed in one rural county

In most Illinois small towns and rural communities there just aren't any good places for a swim, a picnic, or most other types of recreation.

Of 832 Illinois communities under 10,000 population (excluding those in Cook and DuPage counties), only 170 have established public park or recreation facilities. Another 151 are in counties that provide recreation facilities through a forest preserve or conservation district.

Although private gifts can help get a community recreation program started, taxes are almost the only way of assuring its continuation. That many rural Illinois residents would favor tax-supported recreation facilities was indicated by a 1964 survey in Ford County.

For this survey, volunteer workers interviewed 5 percent of the registered voters in the county. A three-part form was filled in for every person interviewed. Completed forms were tabulated and analyzed at the University. Of 280 forms collected, 263 were completed for tabulation.

The first section of the form included questions about the background of the person interviewed. In the second section were questions about attitudes toward five kinds of community recreation facilities. The last section consisted of a hypothetical question to determine how actively a person would encourage or discourage establishment of a local tax-supported recreation agency.

The people in the survey

About half the people interviewed were farm people; half, rural nonfarm. Their ages were as follows:

Age range	*Percent*
21-29	8.4
30-39	22.4
40-49	25.1
50-59	15.6
60-69	12.5
70 and over	10.3
No age given	5.7

About two-fifths (41 percent) had no children living at home; 17.1 percent, one child; 21.7 percent, two children; 9.5 percent, three children; and 10.7 percent, four or more.

Asked what kind of recreation they liked to participate in, the people mentioned 49 different activities. Forty of the activities were mentioned by fewer than eight people. Seven activities were listed by 20 or more. These activities, in order of decreasing popularity, were swimming, picnicking, fishing, boating, bowling, hunting, and baseball. Nearly 30 percent of the people thought that the county's facilities for swimming, picnicking, and fishing were inadequate.

Attitudes toward five facilities

The percentages of farm and nonfarm residents with favorable attitudes toward five types of community facilities are shown in Table 1. The varying attitudes toward each type of facility might be explained by people's different concepts of a specific facility. Some people, for example, might visualize a park as a horticultural display area with man-made ornamental structures, while others might think of athletic fields and free-play areas for youngsters.

As one would expect, the number of children living at home affected the attitudes toward the five types of community facilities (Table 1). Again, people's varying concepts of the first four facilities may explain fluctuations in the data. The fifth facility, the swimming pool, leaves little room for varying viewpoints.

Willingness to participate

As shown in Table 2, farm people were a little more willing than nonfarm people to support taxation for recreational facilities. The majority of both farm and nonfarm people, however, favored the development of public recreational facilities in their communities.

Joseph J. Jopek, Jr., was formerly Instructor in Rural Recreation.

Table 1. — Percentage of Sample Favorable to Five Types of Recreational Facility, According to Residence and Number of Children Living at Home

Facility	Percent favorable						
	Farm	Nonfarm	Number of children at home: 0	1	2	3	4 or more
Park	61.0	66.4	63.9	77.8	75.4	72.0	82.1
Forest preserve	56.8	53.3	53.7	40.0	66.7	72.0	75.0
Playground	59.3	59.0	55.6	86.7	66.7	80.0	76.0
Recreation center with program	46.6	53.3	43.5	71.1	57.9	68.0	50.0
Swimming pool	71.2	72.1	63.9	84.4	86.0	92.0	96.4

Table 2. — Activities in Which Residents Would Participate to Encourage or Discourage Community Recreational Facilities

Activity	Pct. willing to participate: Farm	Nonfarm
Gain all information	53.4	59.0
Attend meetings	60.2	61.5
Support through taxation	69.5	62.3
Actively promote development	44.1	41.8
Write letters to newspapers and officials	18.6	22.1
Lead an effort to discourage	.8	4.1
Complain to a friend or neighbor	.8	3.3
Use the facilities	63.6	73.0
Remain indifferent	5.9	5.7
Participate in an organized effort to discourage	.8	4.1

Cooling and storage facilities used in the experiment.

Approximate Daily Rates of Chilling Shelled Corn to 35° F.

Aver. daily temperature	Aver. relative humidity 30 %	65 %	100 %
	Bushels per ton[a] per day		
70 F.	500	300	200
60 F.	800	500	300
50 F.	1,200	900	600

[a] A ton of air conditioning is equivalent to 12,000 B.t.u. per hour.

COLD STORAGE FOR CORN

GENE C. SHOVE

A COLD AIR drying experiment during the fall and winter of 1965-66 has created a new area of research on grain conditioning and storage.

In a 110-day experiment, over 900,000 pounds of shelled corn was cooled to 40° F. and maintained at this temperature. During this time moisture content of the corn was reduced from about 23 percent to about 19 percent. A heat pump (an air conditioner that can heat as well as cool) was used to condition the air for cooling and drying. This method of removing moisture from grain at low temperatures has been named dehydrofrigidation.

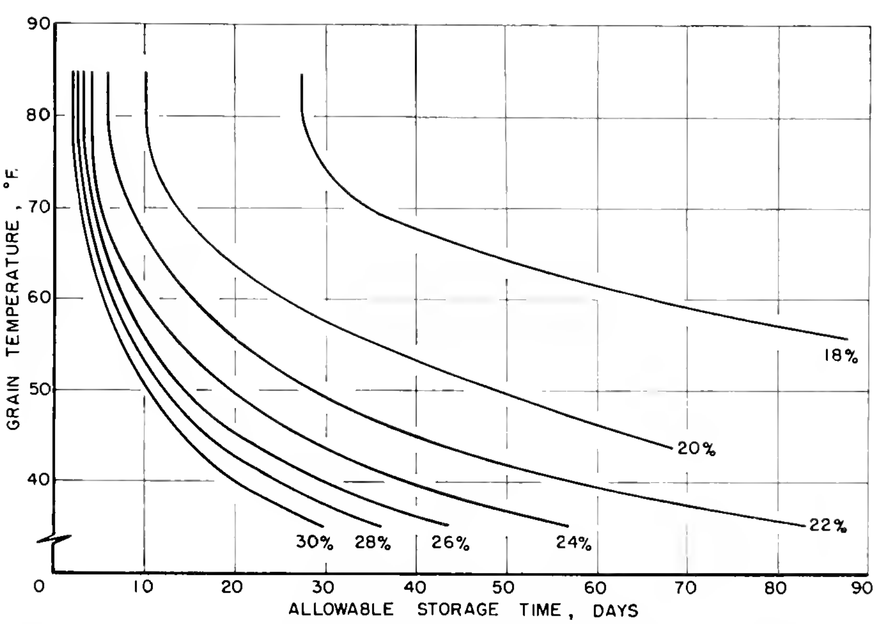
As shown in the chart, 24-percent corn that is cooled to 40° F. without drying will retain its market quality for 40 days. Chilling retards growth of the molds and fungi that cause deterioration of quality. These microflora grow rapidly in warm temperatures, so that shelled grain harvested and stored at 60° to 80° F. can be kept for only a few days.

The allowable storage for corn in the chart is based on the days required for the corn to lose 0.5 percent of its dry matter. Although the relationship between corn quality and loss of dry matter has not been fully evaluated, preliminary results indicate that a loss of 0.5 percent is acceptable, as there appears to be little if any decrease in market quality at this level.

When you extend the allowable storage time of corn by cooling, you increase the number of options that you have for conditioning and marketing corn. For one thing, you have a longer time during which you can market or feed wet grain. You also have a longer time in which to hold the grain for drying at high temperatures. Or you can use dehydrofrigidation to reduce grain moisture. If you want to, you can increase the storage time still further by cooling the grain to 32° F. or below.

Air conditioning equipment can be run round the clock to chill air for cooling grain. Approximate daily cooling rates for a ton of air conditioning are given in the table. According to data obtained thus far, 1 to 3 kilowatt hours of electrical energy per bushel will be required for cooling and removing 10 percentage points of moisture from shelled corn.

Research is being continued on this method of storing and conditioning grain.



Allowable storage time for shelled corn at various temperatures and moisture contents. (Data are from the U.S. Department of Agriculture Grain Storage Research Laboratory, Ames, Iowa.)

Gene C. Shove is Associate Professor of Agricultural Engineering.

RESEARCH IN BRIEF

Relationship Between Biotin Deficiency and Carbohydrate Metabolism in Animals

The vitamin biotin was isolated some 30 years ago and was shown to be identical with the factor that protects animals from the toxicity of raw egg white. The toxicity is due to a protein, avidin, which combines quantitatively with biotin. Since the avidin-biotin complex is not digested by the enzymes of the gastrointestinal tract, biotin deficiency is produced when raw egg white is included in the diet.

In our earlier studies we observed that one effect of biotin deficiency is a marked reduction in protein synthesis in the animal. This is caused by damage to soluble ribonucleic acids, which in turn possibly results from a reduction in the animal's synthesis of adenosine triphosphate. In these experiments biotin deficiency was produced on a raw egg white diet with glucose as the sole source of carbohydrate. When fructose, sorbitol, or sodium succinate was substituted for part of the glucose, protein synthesis in the deficient rat or chick was restored to normal levels. We therefore suggested that biotin deficiency might be accompanied by impaired glucose utilization, resulting in a decreased supply of energy to the animal for synthetic processes.

The decreased utilization of glucose appeared to result from a decrease in glucose phosphorylation. This was reflected in low glucose tolerance, low glycogen and ascorbic acid synthesis, and high excretion of ketone bodies. These symptoms of biotin deficiency are similar to those of mild diabetes. Injection of insulin into deficient animals restored protein and glycogen synthesis in the liver to normal levels.

Further studies revealed a marked reduction in glucose uptake by liver slices from deficient animals, but fructose uptake remained unchanged. The defect appeared to be localized in liver, since glucose uptake by other tissues was not affected. Similarly, glycogen synthesis was affected only in liver and this reduction was not due to a limitation in intestinal absorption of glucose. A marked improvement in glycogen synthesis in liver was observed when fructose was administered instead of glucose.

Enzymes of the glycogen cycle and certain enzymes of the glycolytic, citric acid, and pentose phosphate pathways showed no significant change in activity in biotin-deficient liver. Also hexokinase and fructokinase in liver, and hexokinase in other tissues, were unaffected. However, glucokinase in liver appeared to decrease after about 7 weeks of deficiency. During this stage lipid content of mitochondria decreased and the P/O ratio was also lowered. It appears therefore that biotin deficiency impairs energy production in two ways: utilization of glucose is decreased and oxidative phosphorylation is also decreased.

The nature of the impairment in glucose utilization and the mechanism whereby biotin deficiency induces a nutritional diabetes in animals remain to be elucidated. —*S. P. Mistry*

The Use of Edible Films For the Packaging of Fresh Red Meat

The increasing desire for packaging fresh meats at the wholesale or packing house levels makes it imperative to develop procedures that will keep the meat fresh. So far pre-packaging meats has been only partially successful because it has not substantially increased storage life. An investigation was therefore undertaken to determine whether an edible film could be used to increase the storage life of fresh rib-eye steaks. The three main criteria for evaluating the film were pigment retention, reduction of moisture loss or shrinkage, and reduction of bacterial flora.

Numerous workers have studied the utilization of edible film for meat packaging. An undesirable off-flavor, however, has been noted in all films that have been previously developed. Recent investigations have shown that this off-flavor can be eliminated by using calcium propionate as a fixative in alginate films. This advantage was incorporated into our studies, and a very stable edible film was prepared from sodium alginate, crystalline corn syrup solids, and calcium propionate.

Fresh rib-eye steaks were bought from a local grocer. After samples were weighed and their bacterial count determined, some were dipped in an alginate-corn syrup mixture and the film was fixed with calcium propionate. Both the dipped samples and the untreated control samples were overwrapped with cellophane and stored at 3° C. All samples were evaluated at regular intervals for weight loss, pigment retention, and bacterial count. In several experiments organoleptic ratings were made of odor, flavor, and texture.

After 6 days all the control samples were spoiled, but dipped samples still had low bacterial counts. The dipped samples did not spoil until after 10 to 12 days. A weight loss of 3.2 to 3.3 percent was observed in all samples after 6 days, but after 11 days the weight loss in the dipped samples was only 4.8 percent. Red pigment (oxymyoglobin) was retained in the dipped samples after 10 to 12 days, but the control meat was dark brown (metmyoglobin) in 7 days. After 10 days at 3° C., the dipped samples were judged to have acceptable odor, flavor, and texture.

Storage life of the meat was not improved by incorporation of nicotinamide, nicotinic acid, or ascorbic acid in the film or by a double dip to increase the film thickness. However, storage life was lengthened to 14 days by an extra dip of calcium propionate before the regular treat-

ment of alginate, corn solids, and calcium propionate.

The use of an edible film thus doubled the storage life of fresh steaks. Its use would permit the packaging of meat at the packing house or wholesale house, at a savings to both the meat industry and the consumer. — *Charles G. Pheil and Z. John Ordal*

An Accelerated Lambing Program Raises Profits for Sheep Producers

Sheep producers can increase their production and income by adopting an accelerated lambing program. In such a program, the normal 12-month interval between lambings is shortened to 8 months or less, thereby allowing a ewe to produce more than two lamb crops in two years.

Accelerated lambing proved very successful in an experiment with 19 purebred Rambouillet ewes in the University sheep flock. Their lambs were weaned when about 60 days old to accelerate lambing, and the ewes were then treated for 14 days with a progesterone-like substance to synchronize their heat periods. Pregnant mare serum was given 24 hours before the last progesterone treatment to stimulate ovulation.

Lambing data for the 19 ewes are as follows:

Lambing date	Lambs born		Lambs weaned	
	No.	*Pct.*	*No.*	*Pct.*
Oct., 1964	28	147.4	25	131.6
July, 1965	31	163.2	28	147.4
Mar., 1966	32	168.4	29	152.6

During the 7 years just before the experiment started, the entire Rambouillet ewe flock at the University weaned an average of 1.25 lambs per ewe per year. As shown by the above figures, 4.32 lambs were weaned per ewe during 2 years on the accelerated program. This was an average of 2.16 lambs a year, or 73 percent more than on the regular lambing schedule.

The entire Rambouillet flock of about 90 ewes has now been placed on an accelerated program. The flock has been divided into two groups with schedules as shown below:

Group A		*Group B*	
Bred in:	*Lamb in:*	*Bred in:*	*Lamb in:*
May, '66	Oct., '66	. . .	. . .
. . .	. . .	Sept., '66	Feb., '67
Jan., '67	June, '67	. . .	. . .
. . .	. . .	May, '67	Oct., '67
Sept., '67	Feb., '68	. . .	. . .
. . . . . .	. . . . .	Jan., '68	June, '68

If a ewe in Group A fails to conceive with her allotted group, she is then assigned to Group B for breeding at its scheduled time. This type of scheduling permits a producer to systemize his lamb production to fit a definite diversified farming operation.

To date, no unusual problems have been experienced in the accelerated lambing program. —*B. B. Doane*

A New Test for Quickly Determining the Maturity and Flavor of Sweet Corn

Sweet corn is an exceptionally popular vegetable, either fresh, canned, or frozen. Its maturity at harvest is important. The consumer wants the corn young so that it will be sweet and tender, while the grower wants to leave it in the field as long as possible to increase crop yields and therefore cash returns.

The most common method for determining sweet corn maturity is the "thumb-nail" test, for which the corn is husked and the kernels are punctured with the thumb nail. The ease of puncture and the milkiness or juiciness of the corn endosperm is related to maturity. This test requires considerable experience and judgment, and is not precise. Among the scientific tests, the determination of moisture content by vacuum oven has been the most precise, but it requires 24 to 96 hours. Since maturity at peak quality can change noticeably in 1 to 6 hours, many rapid tests have been devised, but so far these have all lacked accuracy. Needed was a method that was both fast and precise.

Our approach was to seek a rapid test for total solids or nonwater constituents, since this would give moisture content by difference. Total solids in potatoes and dairy products are determined by measuring density (specific gravity). Attempts to measure the density of cut corn by immersion in water have failed because of osmosis and leaching of endosperm constituents from the cut tissue. Therefore, for our work the cut corn was ground with a meat grinder and pressed through cheesecloth so the juice could be taken for density determination.

The procedure that was developed involves use of a pycnometer, which is a small glass vessel that holds about 2 ounces and has a built-in thermometer. The pycnometer is weighed, filled to overflow with precooled sweet corn juice, allowed to stand until the temperature rises to 70° F., and reweighed. The volume of the pycnometer is determined ahead of time by weighing it with water at the same temperature. Density of the juice is simply the net weight of the juice in the pycnometer divided by the volume.

Total time of the test, from cutting the corn to obtaining the final value, was reduced to 15 minutes.

The method was evaluated over two growing seasons. In each season two plantings were made of each of two varieties, Victory Golden and NK 199. Seven to ten pickings were made at regular intervals during maturation of each planting.

Density and vacuum oven moisture content showed an excellent correlation; density changed 0.01 unit for each 2-percent change in moisture content. Since the density is accurate to four decimal places, this method should sense a difference of 0.02 percent moisture.

The ultimate value of such a test is its ability to predict flavor, and this the test does. The degree of correlation between density and flavor was extremely high, even higher than that between vacuum oven moisture and flavor.

Details of the method have been given to sweet corn processors in Illinois and they are evaluating it for their use. —*L. S. Wei, M. P. Steinberg, and A. I. Nelson*

FARM BUSINESS TRENDS

PRICES of farmland have been rising sharply. According to the U. S. Department of Agriculture, average prices for Illinois farmland in March of this year were up 9 percent from the previous November; up 12 percent from March, 1965; and up 32 percent from March, 1960.

Adjoining states east and west had similar increases. During the year ended with March, land values rose 10 percent in Missouri, 12 percent in Iowa and 15 percent in Indiana. Since 1960 prices have increased 41 percent in Missouri, 21 percent in Iowa, and 35 percent in Indiana.

For the nation as a whole, land values in March were up 3 percent from November, 8 percent from the previous March, and 35 percent from 1960.

Farmers continue to be the principal buyers of farmland. They were the purchasers in more than two-thirds of the sales. Owner-operators were the buyers in 51 percent of the sales; tenant farmers in 16 percent; and retired farmers in 3 percent.

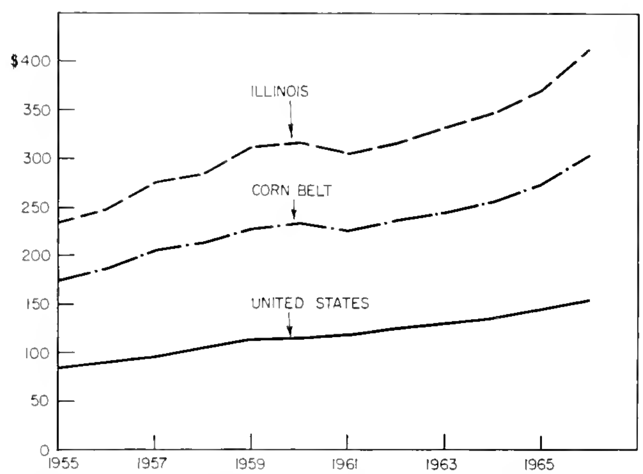
Farmers and other buyers have been bidding up prices of farmland primarily because farm income has been increasing. Annual cash receipts from sales of products of Illinois farms increased from \$1.7 billion in 1955 to \$2.4 billion in 1965 (Fig. 1).

Other factors contributing to the rise of land values are the need for farm enlargement, demand for land for nonagricultural uses, and desire for an investment that is a hedge against inflation.

Illinois farmland must be the best in the nation, judging from its price in relation to prices in other states. According to the U. S. Department of Agriculture, the average price of Illinois farmland in March was \$417 an acre (Fig. 2).

Only five states had higher average prices. Of these, four were on the East Coast, where land prices are boosted by the nearness of large cities, and the fifth was California, where the value of farmland is raised by large investments for irrigation. — *L. H. Simerl*

Cash receipts from sales of Illinois farm products, amount and percent of U. S. total, 1955-1965. (Fig. 1)



Average price of farmland per acre, Illinois, corn belt, and United States, 1955-1966. (Fig. 2)

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

A new highway spreads across the land. Farmers and highway authorities need to cooperate closely in solving drainage problems (page 8).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell . . . . Director

Adrian Janes . . . . Station Editor

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

NEWS AND VIEWS

Working Together in Research

IN THIS country, publicly supported research in agriculture is conducted by the several units of the U.S. Department of Agriculture and by the 53 state agricultural experiment stations. These agencies have worked closely together for many years to develop a truly national agricultural research establishment, and are continuing to explore ways of improving program planning and cooperation.

The most effective coordination is achieved by locating U.S. Department of Agriculture scientists at the state experiment stations, where they are in daily contact with their state colleagues. At present, 37 U.S. Department of Agriculture scientists are based on the Urbana campus, sharing laboratories and other facilities with station scientists in agronomy, agricultural economics, agricultural engineering, and plant pathology. The U.S. Department of Agriculture scientists not only increase the research output of the Illinois station, but they also help to train graduate students, participate in seminars, and take part in the many other research-related activities of the academic community.

The regional research program, begun 20 years ago, has greatly helped to coordinate the planning and conduct of research. Under this program, the United States is divided into four regions. Within each region, research scientists and administrators interested in specific areas of research, meet regularly to analyze regional research needs, evaluate current cooperative projects, and plan future work. Both the state experiment stations and the U.S. Department of Agriculture are represented.

At present, scientists of the Illinois station are engaged in 26 regional research projects. Illinois scientists are also serving on 125 regional committees which continuously examine research needs in all phases of agriculture. These committees identify problems that can be most effectively studied on a multi-state or regional basis, and advise state and federal administrators on priorities and on funds and facilities needed.

Right now, relatively few research facilities are operated on a regional or inter-agency basis, but as the cost and complexity of such facilities increase, more of them will probably be jointly operated thereby providing added opportunities for cooperation among the various agencies engaged in agricultural research. — *M. B. Russell*

MINERALS: Their complex and varied functions in the bodies of animals

R. M. FORBES

As soon as one question about the mineral requirements and metabolism of animals is answered, several others rise up to take its place. Seeking answers to these questions is one area of research in the Division of Nutritional Biochemistry of the Department of Animal Science.

Minerals in body

One point that has been fairly well established by research at various institutions is that minerals make up 4 to 6 percent of the body of a vertebrate animal. Most of this percentage consists of calcium and phosphorus in the skeleton.

Percentages of the different minerals in the adult animal are very similar for all species. Average percentages for nine of the minerals that are essential to animal life are: calcium, 1.1-2.2; phosphorus, 0.70-1.20; magnesium, 0.045; potassium, 0.30; sodium, 0.15; chlorine, 0.15; iron, 0.008; zinc, 0.003; copper, 0.0003.

Other essential minerals found in all animal bodies are sulfur, manganese, cobalt, iodine, molybdenum, and selenium. A complete analysis of animal tissues will reveal traces of many more mineral elements. Some of these may eventually be demonstrated to be essential; others are not essential: and still others are toxic even in small amounts. Fluorine occupies a peculiar position in that it is nonessential and toxic, but at the same time distinctly beneficial in preventing tooth decay under conditions that otherwise lead to caries.

Absorption of minerals

Most of the minerals in animal tissues have been ingested with food and water. Usually they enter the body by way of the small intestine, from which they are absorbed into the bloodstream.

Some minerals are readily absorbed across the intestinal wall into the bloodstream by simple diffusion processes. Others are absorbed with greater difficulty and require hormones or other activators to permit efficient absorption.

Sodium and chlorine are examples of readily absorbed elements. Calcium is absorbed much more slowly. Its absorption is regulated at least in part by hormones and diet. Parathyroid hormone stimulates calcium absorption. Other stimulants include vitamin D and relatively slowly absorbed carbohydrates such as lactose. The absorption of some elements is also regulated by the store of a particular element in the body. Iron absorption, for example, often increases with the animal's need.

Mineral absorption is inhibited when the diet includes components that tend to reduce solubility of minerals at the pH of the intestinal contents. Too much phosphate in the diet will inhibit absorption of calcium, iron, and magnesium. Excesses of calcium will inhibit absorption of phosphate, magnesium, and zinc.

Excretion of minerals

Absorbed minerals are excreted by way of the intestinal and urinary tracts and in sweat. Which excretory pathway will be used depends partly on the mineral in question. It also depends upon dietary, hormonal, and environmental factors which interact to control mineral concentrations in the body.

Calcium, magnesium, phosphorus, and zinc are excreted primarily by way of the intestinal tract. In fact, only small amounts of calcium and zinc are found in urine. The amounts of magnesium and phosphorus in the urine may be somewhat greater, particularly when there is an excess of acid-forming ions such as chloride or phosphate in the ration.

Sodium, potassium, and chlorine are primarily excreted in the urine. This process is largely regulated by aldosterone, a hormone produced in the adrenal gland. Very little absorbed iron is excreted in either the urine or the feces.

In the human, sweat can be an important pathway of mineral loss, especially for sodium, chlorine, and iron.

Role of minerals

Minerals play such diverse roles in the body that it is impossible to summarize them simply. Indeed, the functions of minerals involve the entire field of nutritional biochemistry.

Some minerals are an essential part of the body's structure. Calcium and phosphorus in bone, for example, provide most of the body's structural rigidity. Sulfur is an integral part of a number of organic structures including proteins (the amino acids methionine and cysteine), vitamins (biotin, thiamine), and a wide variety of sulfated polysaccharides. Furthur examples of the structural role of minerals include cobalt in vitamin B_{12}; iron in hemoglobin; iodine in thyroxine; phosphorus in proteins; and iron, copper, molybdenum, zinc, and magnesium in a diversity of enzymes.

Minerals also have regulatory functions in the body. As one example, sodium, potassium, and chlorine are important in regulating pH and in maintaining normal water content of the tissues. These three minerals, together with calcium and magnesium,

R. M. Forbes is Professor of Nutritional Biochemistry, Department of Animal Science.

are much concerned with neuro-muscular irritability and the transmission of nerve impluses.

Activators of enzymic reactions include calcium, for prothrombin synthesis; magnesium, for phosphate transfer; and magnesium, manganese, copper, iron, and zinc, for transfer of hydrogen, oxygen, and many organic molecules. The exact mechanism whereby the minerals function either as activators of enzyme systems or as constituents of enzymes is not known. However, evidence is accumulating that, as constituents of enzymes, minerals may give stability to the configuration of the protein molecules and may also provide sites for ionic attraction and binding of reactants to each other in a manner that lets the reaction take place.

According to other recent evidence, ribonucleic acids contain significant concentrations of trace metals such as chromium, nickel, and manganese, tightly bound in the molecule. Since ribonucleic acids transmit genetic messages for the synthesis of proteins in tissues, the trace minerals may be needed for the correct expression of genetic traits.

Mineral requirements

Whenever attempts have been made to measure an animal's mineral requirements for normal growth and maintenance, the results have varied greatly. Among the factors causing these variations are dietary constituents, age of the animal, and physiological function (such as growth, lactation, or egg production) for which the mineral is needed.

An adult animal's maintenance requirement for a mineral will depend partly on the level to which the animal is accustomed. For example, the amount of calcium required for calcium equilibrium may be drastically reduced in animals that are adapted to low-calcium diets. This principle is true of other nutrients as well as minerals, and represents a fertile field for investigation in all areas of nutrition and biochemistry.

In general, the mineral requirements for growth reflect the mineral accumulations in the total body, modified by rate of turnover in the tissues and dietary factors that influence availability of the mineral to the animal.

In view of these considerations, it would be presumptuous to try to spell out mineral requirements too specifically. The most that can be done is to present guides that represent our best estimates to date. Such guides are given in Tables 1 and 2 for humans, ruminants, swine, poultry, and rats.

On the basis of these guides, some general recommendations may be made for mineral supplementation of human diets or livestock rations. As a rule, if a human diet contains a variety of animal and vegetable foodstuffs, it will not need specific mineral supplementation. Farm animals, whose rations are usually tailored by man for the greatest production rate, will ordinarily need supplements of calcium, phosphorus, and sodium. Other supplements will be needed in specific cases. Manganese is added to most poultry rations, for example. In some parts of the world supplements of cobalt, copper, and selenium are beneficial in the rations of grazing animals. Iodine supplementation benefits all species of animal life in widespread areas of the world.

Table 1. — Estimated Dietary Mineral Needs of Adult Humans[a]

Element	Gm. daily	Element	Gm. daily
Ca	.8-1.4	Mg	.3
P	.8-1.4	Fe	.01-.015
Na	3.0	Cu	.001-.002
K	.8	I	.00025

[a] Estimated from data published by the National Academy of Sciences-National Research Council committee on human nutrition.

Table 2. — Estimated Dietary Mineral Needs of Ruminants, Swine, Poultry, and Rats[a]

Element	Ruminants	Swine	Poultry	Rats
	Percent of ration			
Ca	.12-.5[b]	.6	1.0-2.8[d]	.6
P	.12-.5[b]	.4	.7	.5
Na	.2	.2	.15	.05
K	.....	.3	.18	.18
Mg	.06	.04	.05	.04
Fe	......	.008[b]	.004	.0025
Cu	.0006	.001[b]	.0004	.0005
I	.00008	.00002	.000035	.000015
Zn	.001	.001-.005[c]	.001-.005[c]	.0012
Mn	.004	.004	.005	.005
Co	.0001	.....	.....	......

[a] Estimated from data published by the National Academy of Sciences-National Research Council committee on animal nutrition.
[b] Higher values are for young animals.
[c] Higher values are for diets containing phytic acid.
[d] Higher values are for laying hens.

Minerals may be toxic

All minerals may be harmful if consumed in excessive amounts. The ways in which excess minerals can harm animals are as diverse as their functional roles. Sometimes the harm may be due to a change in the absorbability of the element. Other times, one element may be replaced by another in an enzyme system, or a metabolic reaction may be directly inhibited.

The toxicity of mineral elements may be partly due to the supply of other minerals in the diet. Copper toxicity, for example, is increased by low levels of molybdenum, while molybdenum toxicity reflects, at least in part, an induced copper deficiency. Both of these interactions are modified by the level of inorganic sulfate in the diet. Zinc tolerance in animals is enhanced if intakes of copper and iron are increased above normal levels. Selenium toxicity may be alleviated by judicious administration of a variety of arsenic compounds.

Proper mineral nutrition must be based on a consideration of the potential hazards of mineral excesses as well as of deficiences.

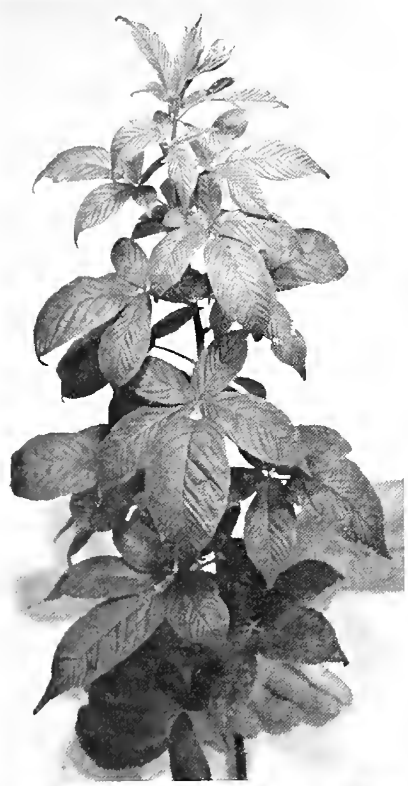
THORNLESS ERECT BLACKBERRIES

May Be Bred From a Wild Selection

C. C. ZYCH, J. W. HULL, and J. C. McDANIEL

ANYONE who has had to train or pick blackberries can appreciate the value of thornless plants.

Several thornless trailing varieties have been in cultivation for many years. These include Thornless Boysen, Thornless Logan, and Thornless Young. Though not very hardy, they may be grown in Illinois with winter protection. Recently a thornless semi-trailing variety, Thornfree, was introduced by the U.S. Department of Agriculture. It has survived several winters at Carbondale and at Urbana without winter protection.



At top, a new cane of the Whitford Thornless Blackberry, showing the very erect growth habit and healthy foliage. Below, some foliage has been removed from the cane to show the deeply furrowed, prickle-free stem. (Fig. 1)

The situation is quite different with erect blackberries. Although some wild species lack thorns, the thornless character has not yet been combined with all the other characters desired in a commercial variety.

A thornless clone of wild blackberries, discovered near Farina, Illinois, may prove to be a source of thornlessness in breeding erect blackberries. The selection is called "Whitford Thornless" after its discoverer, the late A. M. Whitford. Its canes are very erect, deeply furrowed, and completely free of prickles (Fig. 1). Rudimentary prickles occur on the underside of leaf petioles, but these are insignificant compared with the prickles usually found on blackberries. After self-pollination, plants of this selection have produced some seedlings with no prickles at all. The thornlessness is not chimeral, since sucker plants produced from the roots are also thornless.

Genetically, the thornlessness of Whitford Thornless is a recessive character. Thus, when the variety is crossed with thorny varieties, the resulting seedlings are all thorny, and further populations must be grown to recover the thornless character.

The plants produce suckers prolifically. To date, none of the plants either at Urbana or Carbondale has been seriously infected by any of the common blackberry disease organisms. The canes are quite hardy at Carbondale but often show severe winter injury at Urbana.

Flowering and fruiting are profuse.

Fruiting cane of the Whitford Thornless. Medium to small size fruit is abundantly produced during a relatively long period of 3 weeks. (Fig. 2)

While some flowers are complete and normal, others are very small, lacking petals or anthers or both. These incomplete flowers are not the terminal ones, but are lower down on the inflorescence. They open before the terminal flowers and are fertile when properly pollinated.

The fruit matures at about the same time as the Darrow variety. In a non-replicated comparison at Carbondale, 25 Whitford berries weighed 0.10 pound as compared with 0.15 pound for 25 Darrow berries. The thornless selection yielded 13,800 pounds of fruit per acre; Darrow, 10,000 pounds.

Whitford Thornless appears to have much potential as a source of thornlessness in erect blackberries, and has been distributed to a few breeders at other locations. It is not, however, considered suitable for commercial production.

C. C. Zych is Assistant Professor of Pomology, Urbana; J. W. Hull, Research Horticulturist, U.S. Department of Agriculture, Carbondale; J. C. McDaniel, Assistant Professor of Horticulture, Urbana.

FEEDER PIGS GO TO MARKET

L. D. HILL and
M. B. KIRTLEY

Organization and operation of two auctions and one contracting agency

THE GROWTH of a specialized feeder pig industry requires an expanding marketing system to move pigs from the producer to the feeder.

As this marketing system increases in size and complexity, buyers and sellers need more information on which to base production and marketing decisions. Some of this information has been obtained in a study of eight southern Illinois counties: Richland, Marion, Wayne, Jefferson, Franklin, Hamilton, Clay, and Edwards.

Marketing facilities in the eight counties included 40 dealers, three general livestock sales, two cooperative auctions, and one agency offering producer contracts. The importance of the different kinds of channels in the area and in the state as a whole is given in Table 1.

Three marketing facilities were studied in detail. Two were cooperative auctions — the Benton Livestock Association at Benton and the Southeastern Livestock Association at Albion. The third, the Interstate Producers Livestock Association (IPLA), was a contracting agency affiliated with the Illinois Agricultural Association.

The Benton auction was organized in 1959 by producers in the surrounding area. In 1965, 25,000 pigs were sold at this auction. Producers' pigs are vaccinated before consignment and are inspected and weighed when delivered to the auction. Individual lots are pooled to provide larger lots of uniform pigs. Producers are paid the pooled price for the weight which they deliver. Pigs that do not meet the minimum standards cannot be sold through the auction. Most of the pigs consigned are produced within 50 miles of Benton. About half of the sales are made to feeders located within 100 miles of the sale.

L. D. Hill is Assistant Professor of Agricultural Marketing; M. B. Kirtley, Associate Professor of Livestock Marketing Extension.

The Southeastern Livestock Association, organized in 1961, handled 23,000 pigs in 1965. It is operated much like the auction at Benton. Producers are concentrated slightly closer to the sale, and a larger proportion of the pigs go to local feeders than in the Benton sale. Marketing charges at both auctions are a percentage of the gross receipts.

The Interstate Producers Livestock Association signs contracts with producers before pigs are farrowed. The manager sets weekly prices. A producer delivers his pigs to an assembly point where they are inspected and sorted. They are then delivered to buyers who have previously placed their orders with the Association manager. The IPLA acts only as a selling agent without taking ownership. The association also provides management assistance through a staff of fieldmen and finances purchases of breeding stock.

In 1965 about 16,000 sows were covered by contracts between IPLA and producers in southern Illinois. Buyers are located primarily in the heavy grain areas of northern Illinois and in surrounding states.

Questionnaires identify problems

A questionnaire was mailed to producers of feeder pigs, buyers, and dealers. The mailing list was compiled from the records of ILPA, the auctions, and the State Department of Agriculture.

Questions covered production practices, market channels used by feeders and producers, and changes in volume and organization of the industry. From the 192 usable questionnaires returned and the records of the three markets, five major problem areas were identified: quality, marketing efficiency, pricing, volume, and operation of facilities.

Table 1. — Percent of Feeder Pigs Purchased Through Alternative Market Channels, 1964

	State[a]	8 counties[b]
Specialized feeder pig auctions	16	26
Other auctions	25	10
Direct sales	33	24
Dealers, contracts, and other sellers	26	40
Total	100	100

[a] Obtained from "Illinois Feeder Pigs Purchased in 1964," Illinois Cooperative Crop Reporting Service, Springfield.
[b] Obtained from survey made by county farm advisers.

Quality

Feeder pig grades are determined on the basis of conformation, freedom from disease, and general appearance. Feeders are less concerned with appearance, however, than with rate of gain, feeding efficiency, and general health — all quality factors that are not easily identified. The packer is interested in still another quality measure — carcass cut-out value of the finished pigs.

Both feeders and producers recognize that groups of pigs differ in feeding efficiency, rate of gain, and cut-out carcass. These differences affect the pigs' value, but the buyer seldom gets information to help him evaluate these characteristics.

Marketing efficiency

Table 2 gives the costs of marketing feeder pigs at the three markets, as well as producer returns and total buyer costs. If only marketing costs are analyzed, the contract market results in the highest cost to the producer, lowest cost to the buyer, and highest total cost. When prices paid and received are included in the analysis, producers receive the high-

Table 2. — Costs and Returns at Three Markets, 1964[a]

Costs and returns	IPLA	Albion	Benton
	$ per hundredweight		
Costs of selected market functions			
Cost to producer	8.28	5.77	5.86
Cost to buyer	.91	2.48	2.46
Net cost to market	0	0	0
Total cost	9.19	8.25	8.32
Producer returns			
Av. price received	32.86	29.39	29.18
Marketing costs	8.28	5.77	5.86
Net returns	24.58	23.62	23.32
Buyer costs			
Av. price paid	32.86	29.39	29.18
Marketing costs	.91	2.48	2.46
Total cost	33.77	31.87	31.64

[a] Costs and prices computed for a 40-pound pig.

est returns at the contract market and buyers have the highest cost. Quality differences were not considered in the analyses, and there may be non-economic factors which would alter the cost-price relationships.

From the small differences shown in these tables, it must be concluded that no one market system is greatly superior in efficiency.

Pricing

The price paid for a particular lot of feeder pigs is affected by four things: size of lot, uniformity of pigs within the lot, weight, and breed characteristics of the pigs.

Lot size and uniformity. The practice of pooling pigs has increased lot size without loss of uniformity. As a result, buyers at the auctions were willing to pay higher prices for larger lots (Table 3). The exception to this pattern was the 51-75 lot size at Albion. The relatively high price for this group was due to the large proportion of small local feeders buying at Albion. The premium for this lot size will decrease as Albion attracts more large feeders. Prices under the IPLA contract are not differentiated according to lot size.

Weight. Price decreases resulting from increases in average weight are shown in Table 4. According to the survey, 38 percent of the respondents preferred to buy a 40- to 50-pound feeder pig. This fact is recognized in the IPLA contract, which specifies a greater discount for increasing weight than prevails at the auctions (Table 4). Actually none of the heavier weights are moved through the IPLA. Average weight at the auctions in 1964 was 61 pounds, with a range from 30 to 180 pounds.

Breed. A statistical analysis of 822 sale transactions at the auctions indicated that pigs showing Hampshire characteristics brought $.63 per hundredweight more than the average of all pigs. While price differentials were found for other breed classifications in particular sales, these differences were not consistent.

Volume

Because of the overhead costs associated with most marketing facilities, unit cost is highly responsive to changes in volume. Operating efficiency in the auctions reaches a peak at a volume of about 2,000 head per sale. Both Albion and Benton have reached this point, Albion averaging 2,460 pigs per sale in 1964; Benton, 2,240. Limitations in capacity of existing auction facilities suggest that further increases in volume must be handled by more sale days rather than larger volumes per sale.

If new facilities were to be constructed, a volume of at least 1,000 pigs per sale would be needed to keep costs competitive with those of alternative market outlets.

Continued expansion and specialization of hog-feeding operations will provide a growing market for feeder pigs. Even so, it is difficult to predict the amount of growth. In expanding present marketing facilities, one must recognize the limitations of demand in the local area and take advantage of opportunities for broadening the market geographically.

Operational problems

In addition to the industry-level problems that have been discussed, all market facilities have many problems in their daily operations. Although these problems become specific for each firm, some generalizations apply to any market system:

Table 3. — Price Increases as Lots Increase Above 25 Head in Size

No. of head per lot	IPLA	Albion auction	Benton auction
	$ per hundredweight		
1-25	0	0	0
26-50	0	1.12	1.40
51-75	0	2.30	1.80
76-100	0	1.33	1.82
101-500	0	2.40	2.25

Table 4. — Price Decreases as Weight Increases Above 40 Pounds

Weight group	IPLA[a]	Albion auction[b]	Benton auction[b]
	$ per hundredweight		
30-40	0	0	0
41-55	− 3.28	− 2.38	− 2.53
56-70	− 7.43	− 6.37	− 6.34
71-85	−10.75	− 9.97	− 9.40
86-100	−13.00	−10.63	−11.03
101-170	−14.61	−12.41	−13.08

[a] Discounts are based on the 1962, 1963, and 1964 average base price of $34.69 for a 40-pound pig. Each pound above the base weight is purchased at 15 cents up to a total weight of 60 pounds. Each pound above 60 is 10 cents. Price differentials shown here were computed as the change from the base to the midpoint of each weight range.

[b] Discounts at the auctions were estimated statistically from sales data. Weight ranges were assumed to be represented by the midpoints and were adjusted to a 40-pound base for comparability. All values were statistically significant at the 1-percent level.

1. For maximum returns and efficiency, demand must be identified accurately and the product adjusted accordingly. An example is offering lot sizes that buyers want.

2. Adequate safeguards such as insurance, bonding, and financing arrangements are needed to avoid undue losses.

3. If quality guarantees are to be effective, producers must be held responsible for the quality and condition of the pigs they sell.

4. The organizational structure should provide enough management and labor that continuity of operation does not depend on any one person.

5. Physical facilities must be adequate to operate the sale at a cost that is competitive with costs of other market channels.

A more complete account of this study has recently been published in Illinois Extension Circular 957.

Laws, practices, and problems related to

HIGHWAY AND AGRICULTURAL DRAINAGE

CARROLL J. W. DRABLOS and BENJAMIN A. JONES

NATURE'S elaborate system of drainage is constantly changing in response to both man and natural forces. Manmade changes may be sudden and extensive. Modern methods of farming and highway construction, for example, often call for reconstruction and even relocation of drainage systems.

Both agricultural and highway drainage systems are designed to remove excess surface and subsurface water. The ultimate purpose of agricultural drainage systems is to create favorable soil conditions for plant growth. Highway drainage systems have the ultimate purpose of maintaining the life of the highway and protecting motorists. Because of these different objectives, agricultural and highway systems differ in the kind of drainage improvements made. At the same time, improvements made for one kind of system often affect the other.

Because of the growing importance of drainage problems and their solutions, a cooperative investigation of the laws and practices relating to agricultural and highway drainage was initiated by the U.S. Bureau of Public Roads, the Illinois Division of Highways, and the Department of Agricultural Engineering, University of Illinois.

One purpose of the study was to search out all Illinois laws applicable to highway and agricultural drainage, and to compile these laws into a single source. The second objective was to explore some of the solutions to engineering problems connected with drainage. The study revealed many of the practices followed by highway and agricultural interests in Illinois and other states.

Carroll J. W. Drablos is Assistant Professor and Benjamin A. Jones is Professor of Agricultural Engineering.

Rights and responsibilities

According to Illinois law, the highway authority and individual landowners have the same basic rights of drainage. Landowners have the right to hold their land in accordance with the natural conformation of the ground. Thus the owner of upper land may drain upon and over the lower land on the principle that nature has ordained such drainage. If a person buys land over which surface water naturally flows, he cannot obstruct, impede, or stop the drainage in any way that will harm the owner of the upper land.

Landowners sometimes believe that the highway authority is obligated to drain adjacent land and protect it from the natural overflow of water. The courts, however, have pointed out that the highway authority does not have this responsibility. On the other hand, the highway authority cannot cause the adjacent land to be overflowed more than it was in its natural state. When highway construction interrupts farm drainage, the general practice of the highway authority has been to restore drainage systems to the approximate standard that existed before construction.

Drainage considered in planning

Long before construction begins, the highway authority follows a systematic process of selecting the most feasible route for a new highway. Drainage is one of the many things considered during this period. The selection process may be divided into four major steps:

1. **Reconnaissance of the region** through which a proposed new or relocated highway is to pass.

2. **Reconnaissance of possible alternate routes** indicated by regional maps and supplementary surveys.

3. **Preliminary** location surveys.

4. **Final** location surveys and preparation of plans. At this time field studies are conducted and pertinent data about potential drainage problems are gathered.

Early understanding important

When a drainage problem concerns both farmers and the highway authority, disagreements sometimes arise about a solution. Often a lack of communication is the basic cause of the disagreement. Proper communication is essential for understanding mutual problems and reaching solutions that are satisfactory to everybody concerned.

It is important that landowners learn about proposed plans at an early stage. A landowner has a responsibility to determine his drainage requirements soon enough that they can be considered and, if feasible, incorporated into highway drainage plans. If he ignores this responsibility, some drainage problems may be overlooked with possible detrimental and costly results in future years. The landowner can also contribute valuable information about local conditions during the planning stage. If problems are considered early, it is possible to take preventive rather than corrective measures.

Public hearings by the highway authority provide an opportunity for landowners to both give and receive information. These hearings are held in the immediate area of a highway project. Plans, specifications, and similar information are generally available to the public and to governmental agencies, including the Soil Conservation Service and the Cooperative Extension Service. These agencies can help interpret the plans and specifications.

A guide for cooperation between

Photographic strip maps like this are an aid in determining a proposed route.

highway officials, landowners, and representatives of various agricultural agencies was developed several years ago by highway officials and numerous agricultural agencies. It was published under the title, "Suggested Guide for Cooperation in Resolving Mutual Problems of Conservation Related to Highway Improvement and Maintenance." Despite its value, the guide has limitations, and further work is being done in this area.

Right-of-way acquisition

After a final location has been selected and field investigations have been completed, the highway authority prepares right-of-way plans and plats. These plans contain recommendations for various facilities, including drainage.

An appraisal is made to determine both the fair cash market value of the land to be taken and the effect that the proposed improvement may have on the market value of the owner's remaining land. A landowner is entitled to just compensation for the land that is taken and for damages, if any, to the remainder.

Right-of-way negotiators have the responsibility of acquiring property for the highway authority. A negotiator explains to the property owner the proposed drainage systems as shown on plans, aerial photographs, and similar materials prepared by the highway district office.

After the negotiator and the landowner reach a mutual understanding, a written agreement between the highway authority and the landowner is drawn up. The agreement is signed by all parties before the highway is constructed. It outlines corrective measures agreed upon during the negotiations, but usually exempts the state from responsibility for further damages. All points of agreement should be placed in writing, because oral agreements are not necessarily binding. It is very important for all parties to analyze their anticipated problems and find solutions that are mutually acceptable before the agreement is signed.

If an agreement cannot be reached with the property owner by negotiation, the highway authority may exercise the right of eminent domain, but this is done only as a last resort.

Typical drainage problems

It is impossible to enumerate the many types of drainage problems encountered by both the highway authorities and individual landowners. However, these are a few of the prominent problems that have been revealed in this study:

Surface drainage systems. Acceleration of water movements, diversion of flow, drainage of ponded areas, obstruction of flow, overflow, provision for outlets, drainage of low areas next to highway, use of highway side ditch as an outlet, accepting diffused surface water, drainage of ponded areas, mutual projects, maintenance responsibilities.

Subsurface drainage systems. Requirements of agricultural subsurface drainage systems, requirements for subsurface facilities within right-of-way, subsurface drainage outlets, highway drains discharging into agricultural facilities, agricultural drains discharging into highway facilities, intercepted tile lines, maintenance of highway facilities receiving agricultural drainage.

Culverts. Attributes of a good highway culvert, responsibility for providing sufficient openings, culvert size, principles of culvert location, provisions for handling wide flows, location of culvert invert, adjustment of flow lines, maintenance.

Erosion control. Control measures, drop box on a highway culvert, surface lining, ditch checks, outlet protection, conservation practices, maintenance.

Borrow areas. Location, excavation, restoration, drainage.

Future drainage. Responsibilities for providing facilities, practices followed by highway authorities.

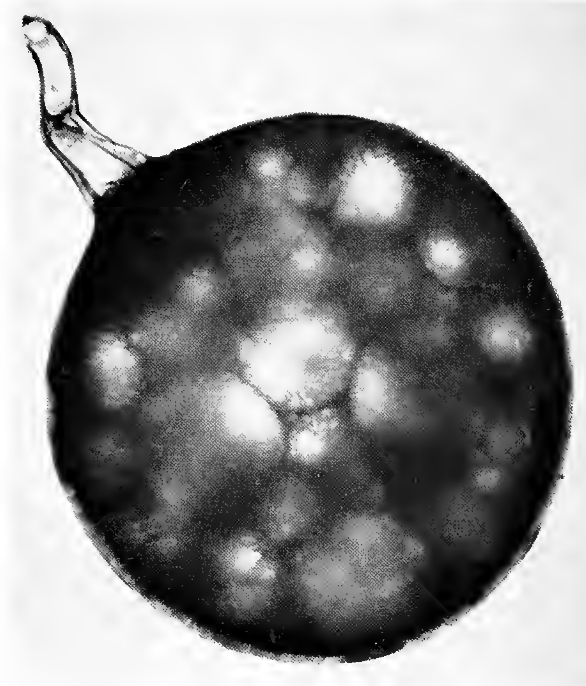
Sewage and pollution. Legal requirements, discharge of effluent.

For more information

Within the scope of this article, it has been possible only to illustrate a few drainage problems and to give some general indications as to how they can be handled. A more detailed analysis of the laws and practices related to highway and agricultural drainage may be found in Illinois Engineering Experiment Station Circular 76, "Illinois Highway and Agricultural Drainage Laws," and Illinois Engineering Experiment Station Bulletin 480, "Highway and Agricultural Drainage Practices."

THE ENDOGONES: Beneficial Soil Fungi

Until recently, the endogones had never been detected in Illinois soils, but these fungi are now known to be abundant, infecting plant roots and increasing the plant's ability to absorb nutrients from the soil



Endogone spores are the largest produced by fungi. Spherical bodies inside the spore are oil droplets. This picture was magnified 275 times. (Fig. 1)

J. W. GERDEMANN

ILLINOIS SOILS are now known to abound in the largest spores that are produced by fungi. There is also good evidence that the fungi producing these spores are beneficial to plants.

The spores are as large as some of the smaller seeds of flowering plants, such as petunias or tobacco, and they can easily be seen without the aid of a microscope. Each spore consists of a single spherical cell and contains a bright yellow oil (Fig. 1). It is strange that such striking objects as these could have been overlooked for so many years.

The fungi that produce these gigantic spores are members of the genus *Endogone*. We now know that endogones are among the most common fungi in both cultivated and forest soils. Until recently, however, they were thought to be quite rare. Most of the species had been collected only once or twice. They had been found in sphagnum bogs or in mosses or leaf litter in forests but never in cultivated soils. No one had ever isolated an endogone from soil in the laboratory, although plant pathologists and soil microbiologists have been isolating other fungi for years.

The reason for the failure to isolate endogone species from soil is quite simple. These fungi will not grow on laboratory media and consequently the standard techniques for isolating fungi are useless.

Isolating and growing endogones

By using a method called "wet sieving and decanting," I found that endogone spores could be extracted from cultivated soil. This method was developed by plant nematologists for separating nematodes from soil.

The soil is mixed with water, and the heavier particles are allowed to settle. The liquid is then decanted through a sieve to remove the larger of the particles still in suspension. Next, the liquid is passed through another sieve with smaller openings that will catch particles the size of the spores. This material, mainly bits of organic matter and endogone spores, is examined under a microscope and the spores are picked out with a flattened needle.

These spores can be used to produce "pot cultures" of endogone species. The roots of plants growing in sterilized soil are inoculated with spores. The spores germinate and infect the roots and produce more spores in the soil.

We have found a number of endogone species in cultivated soils. Most of them have not yet been named or described. Each species has a very wide host range; a single species can infect such diverse plants as corn, onions, red clover, strawberries, and tulip trees.

How endogones grow in plants

When an endogone infects a root it produces a structure called a mycorrhiza, a word which means fungus root. Once the fungus is inside the root, it produces hyphae, the thread-like vegetative growth of the fungus, throughout the root cortex. It also produces vesicles, oil-filled bladder-like objects, either in or between the cells; and arbuscules, finely branched hyphae, within the cells. Since these

J. W. Gerdemann is Professor of Plant Pathology.

very little. In some species, such as corn, the mycorrhizal portions of the root can be recognized by their yellow color. This color quickly disappears, however, when the roots are exposed to bright light.

These corn plants are both growing in infertile soil. The one on left was infected by an endogone species; the one on right was not infected. (Fig. 2)

The response of tuliptrees to mycorrhizal infection by an endogone species is similar to that of corn. Plant on left was infected; that on right was not. (Fig. 3)

two structures are characteristic of this kind of mycorrhizal fungus, it is usually referred to as a vesicular-arbuscular mycorrhiza.

The fungus probably derives its food from the root through the arbuscle and stores most of it as oil in the vesicles and in the spores. While the fungus is growing through the roots, it also produces a network of hyphae in the soil. We believe that the fungus cannot grow in the soil unless it is attached to hyphae in the living root.

When a root becomes mycorrhizal, its external appearance is changed very little. In some species, such as corn, the mycorrhizal portions of the root can be recognized by their yellow color. This color quickly disappears, however, when the roots are exposed to bright light.

Fungus beneficial

A different kind of mycorrhiza which forms on pine and beech trees has been studied for many years. There is abundant evidence that the fungi involved absorb nutrients from the soil and release a portion of them to the roots. The mycorrhizal tree generally grows much better than one that is not infected.

Until quite recently the function of the vesicular-arbuscular mycorrhizas, which occur on nearly all crop plants and many kinds of trees, was unknown. Some people assumed that they must benefit their hosts; however, a number of plant pathologists believed that they were pathogenic and caused root diseases. Actually there was no experimental evidence to support either point of view.

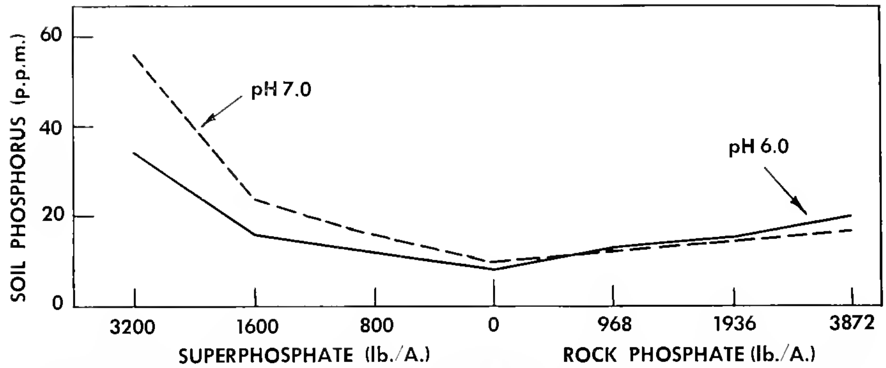
We now have evidence that the vesicular-arbuscular mycorrhizas function in much the same way as the better known type of mycorrhiza on pine and beech. In most experiments mycorrhizal plants make much better growth than nonmycorrhizal plants (Figs. 2 and 3).

Mycorrhizal infections give the greatest benefits in soils that are relatively infertile. As the soil nutrient levels are increased, the differences between mycorrhizal and nonmycorrhizal plants becomes less.

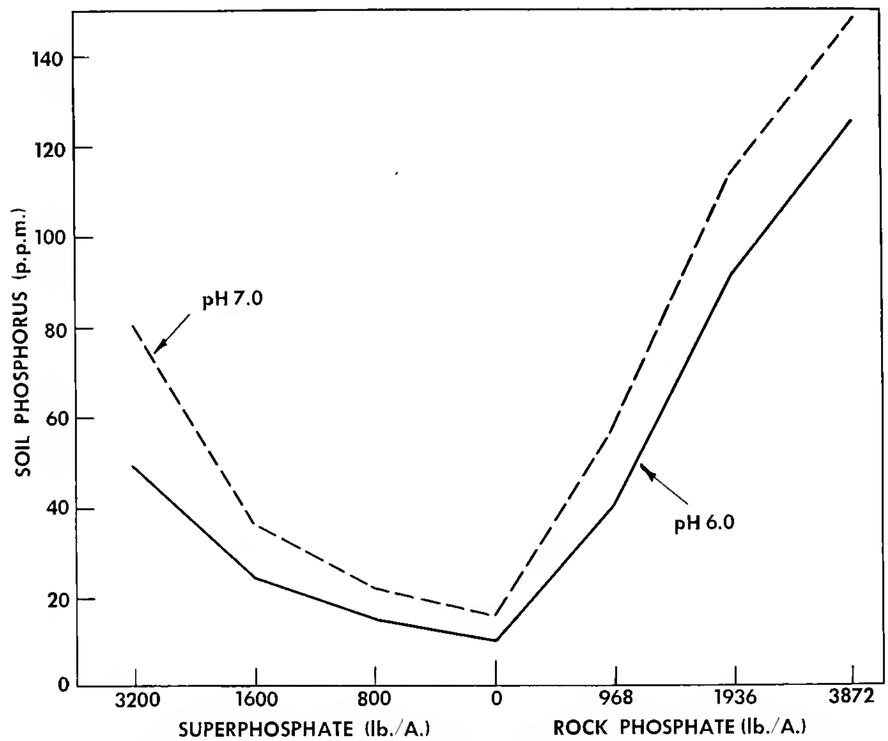
In some way that is not well known the mycorrhizas increase the plants' ability to absorb nutrients from the soil. We have evidence that mycorrhizal plants are better able to utilize the less available forms of soil phosphorus than are nonmycorrhizal plants. It is also possible that the hyphae which are attached to the roots function as root hairs and thus greatly increase the absorbing surface of the root. Since the hyphae grow for some distance into the soil, they may increase the distance from which a root can obtain nutrients.

How Soil Tests for Phosphorus Are Affected by Phosphate Source and by Lime

W. M. WALKER, L. B. MILLER,
T. R. PECK, and P. E. JOHNSON



How rates of rock phosphate and superphosphate affect the P_1 test for available soil phosphorus at two pH levels in a 4-year rotation. (Fig. 1)



How rates of rock phosphate and superphosphate affect the P_2 test for reserve soil phosphorus at two pH levels in a 4-year rotation. (Fig. 2)

Some of the interrelationships between phosphorus source, soil pH, and crop rotation are being brought out in a study at the Brownstown Agronomy Research Center.

The experiment has been going on since 1950. Soil type is Cisne silt loam; cropping sequence is corn, soybeans, wheat, and hay. All plots received 5 tons of lime per acre in 1950, and half the plots received an additional 5 tons per acre in 1957.

Two sources of phosphate were tried with each level of lime application. Rock phosphate was applied at rates of 484, 968, and 1,936 pounds per acre in 1950 and again in 1957. Superphosphate (0-20-0) was applied to corn and wheat in the crop sequence at rates of 100, 200, and 400 pounds per acre. Total amounts of phosphate applied per acre since 1950 thus add up to 800, 1,600, and 3,200 pounds of superphosphate; and 968, 1,936, and 3,872 pounds of rock phosphate.

Soil phosphorus was determined by two procedures, both developed by Dr. R. H. Bray, Professor of Soil Fertility Emeritus. The Bray test number 1, or P_1, measures available soil phosphorus; test number 2, or P_2, measures reserve phosphorus. Soil pH was also measured. The results reported here are based on samples taken in November, 1965.

Figure 1 shows how the two phosphate sources affected the test for available soil phosphorus at two pH levels. As levels of superphosphate increased, the supply of available phosphorus rose spectacularly. This was true at both pH levels, but particularly at pH 7.0. Rock phosphate had a much smaller effect on available soil phosphorus, and this effect was not much influenced by soil pH. Since approximately the same amounts of phosphate were applied to the two series of plots, the difference in phosphate levels is probably due to a difference in the forms of phosphates in the soil.

Rock phosphate built up reserve soil phosphorus much more than superphosphate did, although superphosphate had a marked effect (Fig. 2). Increases were greater with a pH of 7.0 than with a pH of 6.0.

The two sources of phosphorus did not differ significantly in their effects on yields of corn, soybeans, or hay. However, superphosphate was a significantly better source of phosphorus for wheat. Crop yields were higher with a pH of 7.0 than with a pH of 6.0, but differences were slight for all crops except wheat.

The authors are all Assistant Professors in the Department of Agronomy.

County Planning Takes Hold in Illinois

JOHN A. QUINN

COUNTY comprehensive planning is being discussed and debated on every side these days. Such planning terms as "urban sprawl," "open space," and "renewal" have become part of our everyday language.

People are investigating county comprehensive planning as a means of coordinating the planning activities of local government units — which number more than 4,000 in Illinois. Comprehensive planning is also getting a big boost from federal and state assistance programs. More and more of these programs are suggesting or requiring comprehensive planning as a prerequisite for assistance.

By now 53 of the 102 counties in Illinois have established comprehensive planning programs. Some counties have developed their programs individually; others are cooperating with other counties.

The growing interest in county comprehensive planning is reflected in the requests for information and assistance that have been coming into the Cooperative Extension Service and the Bureau of Community Planning. Among the counties requesting assistance have been Jo Daviess, Stephenson, Carroll, Ogle, Whiteside, and Lee, in the northwestern corner of the state. In response to the requests from these counties, a short course in county comprehensive planning was held in November of 1966.

The course consisted of four two-hour sessions designed to parallel the formulation of a county master plan. Following are brief summaries of the four sessions.

1. Planning for the layman

All planning activities should consist of four basic steps: (1) collection and analysis of data; (2) plan formulation; (3) implementation; and (4) evaluation and restudy. All too often, however, the planning process stops short of implementation.

Under Illinois law, community planning may be carried on by two types of organization: (1) a department of planning similar to the local engineer's office, or (2) an officially appointed citizens' planning commission. Some communities have used both types of organization to take advantage of the strong points of each. Whatever organization is used, ultimate responsibility rests with the local government, whether county board or city council.

Often, a planning organization employs a private consulting firm to provide technical assistance. Financial assistance is being increasingly sought from the Federal-State Urban Planning Assistance Program (commonly referred to as the 701 Program). Assistance under this program can amount to two-thirds of the planning costs.

2. Land use planning

Land use is the basic focus of comprehensive planning. It involves population, the economy, investments in public facilities and services, and private developments, both existing and anticipated.

Basic questions are: How is our land currently being used? What demands for space are likely? Can these demands be met? Different intensities of use generate varying requirements. There are the demands of pedestrian versus vehicle traffic, for example, or of automobiles versus heavy trucks. Such questions as water tables and sewage also need to be considered.

Sources of information never before used for community planning are being injected into new planning programs. Soils data are being interpreted for urban use capability, for example, expanding the usefulness of both the data and the programs.

3. Need for coordination

Since all government units plan, a vast array of planning activities are always going on — for schools, highways, public health, utilities, recreation, industrial development, and various other services and facilities. With all these varying plans, there is bound to be competition for land and other resources.

A major function of comprehensive planning is to encourage the various government agencies to coordinate their diverse plans. Comprehensive planning can not only reduce competition among the various planning units but can also eliminate duplication of effort in such areas as economic and population research. A further advantage is that comprehensive planning groups can provide other groups with new information that will help forestall errors in judgment.

4. Implementation essential

Completion of the community master plan marks the end of step 2 in the planning process and should launch step 3 — implementation. No matter how technically sound a master plan may be, or how well it may be received, the time, effort, and money invested in it will be of little use if the plan is not put to work.

The completed plan consists of two mutually dependent documents — a map and a text. The two together should represent the objectives of the community in general and should serve as a policy statement for guiding investments and decisions involving the community's future.

Usually implementation involves control codes for land use, such as zoning and subdivision regulations, and building codes. For if the community is willing to invest in the future, it should have some assurance that its investments will be protected and will be as sound as good, reasoned judgment can make them.

John A. Quinn is Assistant Professor of Community Planning, Department of Agricultural Economics and Bureau of Community Planning.

RESEARCH IN BRIEF

Supplemental Light Benefits Growth of Tomatoes and Cabbages

It is well known that vegetable plants grow more slowly in winter and early spring than in summer. Two experiments during 1966 tested the hypothesis that artificial light would accelerate growth when days are short.

Tomato and cabbage plants were grown in the greenhouse at Urbana under three light conditions: (1) natural day; (2) natural day supplemented with 8 hours of artificial light — from 4 a.m. to 8 a.m. and from 5 p.m. to 9 p.m.; (3) natural day supplemented with 17 hours of artificial light — from 4 a.m. to 9 p.m. Commercial 400-watt, color-improved Mercury lamps with good emission in the red portion (650-700 mu) of the spectrum were placed 30 inches above the plants. They provided an energy source totaling about 900 foot-candles.

In the first experiment, 9-day-old plants were placed under supplemental lights on March 11 and were harvested after an additional 20 days. In the second experiment the plants were placed under the lights on April 25 and were harvested in 24 days. Total plant fresh weights were recorded for both experiments.

In Experiment 1, 8 hours of supplemental light daily (160 total hours) increased the fresh weight of tomato plants by 76 percent and of cabbage plants by 83 percent. Supplemental light for 17 hours a day (340 total hours) gave an increase of 112 percent for tomatoes and 134 percent for cabbages. It appears that about 200 hours of supplemental light would have doubled plant growth.

In Experiment 2, supplemental light did not benefit growth. It was therefore concluded that Urbana gets enough natural sunlight for maximum growth of tomato and cabbage plants after April 25.

Supplemental light may have commercial potential for growing such winter greenhouse vegetables as lettuce and tomatoes. These crops are grown from transplants that can be conveniently concentrated under lights. Supplemental light may also be of value for early field vegetables. Further work is in progress to study the response of vegetables to supplemental light and to determine the economic feasibility of this practice. — *J. S. Vandemark, S. A. Garrison, and J. W. Courter*

Effect of Progestin Injections on Weight Gains of Fed Heifers

Cattle feeders have always been concerned about the weight loss that may occur in heifers as a result of restlessness caused by estrus. The practice of breeding heifers that are to be finished eliminates the activity of the heat period. However, the sale price of fat females is reduced to compensate for the weight loss due to removal of the fetus and other embryonic material at slaughter. In some areas feedlot heifers are spayed, but the cost and risks have not made the practice popular.

An experiment was conducted at the Dixon Springs Agricultural Center to determine the effect of a synthetic progestin on occurrence of estrus and weight gains of heifers being fed for slaughter. Sixty long-yearling heifers were divided into two lots. One group received two injections of progestin, 63 days apart, under the skin of the ear. The other group was left as an untreated control. Estrus apparently ceased in the treated heifers about the third day after the hormone was administered. By the time of the second injection one heifer showed signs of heat.

Both lots were self-fed a ration containing 78 percent ground ear corn, 12 percent ground hay, and 10 percent soybean meal. Salt and a mineral mix were always available.

The heifers averaged 610 pounds at the start of the study and were fed to about 950 pounds finished weight. As shown below, heifers receiving the hormone gained faster than the control group:

Heifer group	*Daily gain, lb.*	*Feed per lb. of gain, lb.*
Treated	3.07	8.94
Untreated	2.77	9.12

The difference between the two lots in weight gain was significant at the 0.05-percent level. The more rapid gains of the treated heifers may be due to the elimination of estrus. Part of the response can possibly be attributed to the growth-promoting quality of the hormone. — *G. F. Cmarik and F. C. Hinds*

Squirrels Damage Trees in Northern Illinois

Hackberry and boxelder trees along Rock River from Dixon to Rockford suffered serious damage from fox squirrels last summer — mostly between July 15 and August 15. At least one black oak was also attacked.

Damage took the form of limb

Large hackberry with nearly two-thirds of its crown dead or dying because of damage by fox squirrels.

girdling. The squirrels actually peeled the bark from limbs 2 to 4 inches in diameter and ate the inner bark from the pieces removed. As much as two-thirds of the total crown of a large hackberry tree might be killed in this manner.

Not all trees were attacked, but on Sinnissippi Forest, where damage was first noted, about 75 percent of the hackberries along the river were damaged to some extent, with about 25 percent of these being damaged extensively. Boxelders were damaged less than hackberries. — *Howard W. Fox*

How the Antibiotic Filipin Inhibits Growth of Fungi

Among the many antibiotics that inhibit or prevent the growth of microbes are a number that inhibit fungi. One such antibiotic is filipin, which inhibits a wide range of fungi, including many plant pathogens.

Our recent studies have concerned the mechanism of filipin's action. Filipin's prime point of attack is the cell membrane, which regulates the entrance of nutrients into the cell as well as the exit of waste products. In all fungi that are inhibited by filipin, an integral part of the cell membrane is ergosterol. An occasional fungus has no ergosterol and is not inhibited by filipin. If such a fungus is grown in a medium containing ergosterol, it will incorporate the chemical into its membrane and become sensitive to the antibiotic.

The antibiotic removes the ergosterol from cell membranes by combining with that component, and thus destroys the selective permeability of the cell membrane. Now those soluble materials that are essential for the life of the cell leak out and can be detected outside the cell. The fungus can no longer absorb nutrients in the right proportion and at the required rate. After a time of exposure to filipin, the fungus dies.

Death of the fungus can be prevented by putting a sterol in the nutrient medium along with the filipin. The sterol apparently enables the cell to repair its membrane. Leakages stop and growth goes on its normal pace.

The specific role of filipin in reacting with sterols helps us to explain the fact that the antibiotic does not prevent the growth of bacteria. Most bacteria do not need sterols in their cell membranes for the regulation of permeability; thus filipin has no effect on them. — *David Gottlieb*

Large Core Sampler Extracts Undisturbed Soil Samples in Gallon Containers

Collecting large, undisturbed soil core samples from forest soils presents particular problems. If No. 10 cans are driven directly into the soil, they are damaged by tree roots, rocks, and other obstructions, and soil samples are often spoiled. A core sampler was therefore designed and fabricated to permit extraction of soil in a No. 10 can without damaging either the can or the sample.

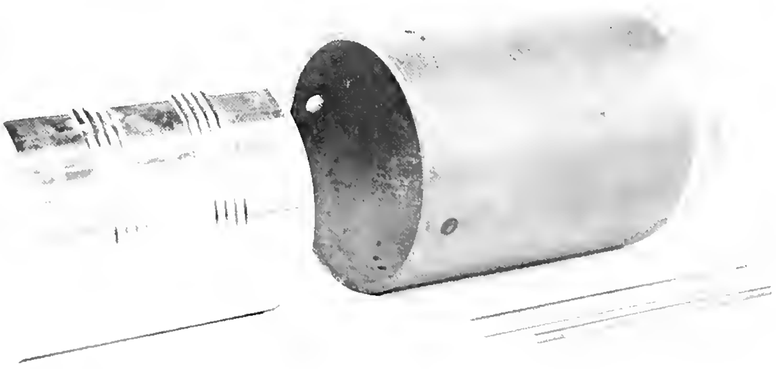
The sampler is constructed from tubular steel turned down with a metal lathe to accommodate a No. 10 can. When placed inside the sampler, the can rests on the sampler's cutting edge and is held in place with a retaining rod. With the top of the can removed or punched with holes, air escapes when the sampler is driven into the soil.

The sampler is driven into the soil with a small sledge hammer. A block of wood on top of the sampler absorbs shock and prevents damage to the sampler. To assure good samples with minimum disturbance, the surface soil layers are cut around the base of the sampler before it is driven into the soil.

The can, filled with soil, may be withdrawn from the sampler after the retaining rod is removed. The bottom of the sample is carefully smoothed with a large knife and covered with a piece of cheesecloth held in place with rubber bands.

Soil extracted with the large core sampler is less disturbed and more representative of the area being sampled than is soil sampled by driving unprotected tin cans into the soil. — *Larry J. Burkhart*

A block of wood absorbs shock and keeps the sampler from being damaged as it is driven into the ground.



A No. 10 can is placed inside the sampler and held in place with a retaining rod.

FARM BUSINESS TRENDS

SOYBEANS apparently became the leading cash-producing crop of the nation in 1966. Official figures may not be available for several months, but it appears that soybeans outraced corn for the top spot in cash receipts from crop sales.

Longtime king cotton probably tumbled to fourth place as a result of sharply lower prices and a short crop. Wheat, which held second place for many years, slipped to fourth in 1964 and 1965 but likely beat out cotton for third place in 1966. Tobacco continued in fifth place, the same as in recent years.

Soybeans are the newest major crop in the United States, though they have been grown in the Orient for hundreds of years. Some were brought to the United States as early as 1804, but nothing much was done with them for more than a century.

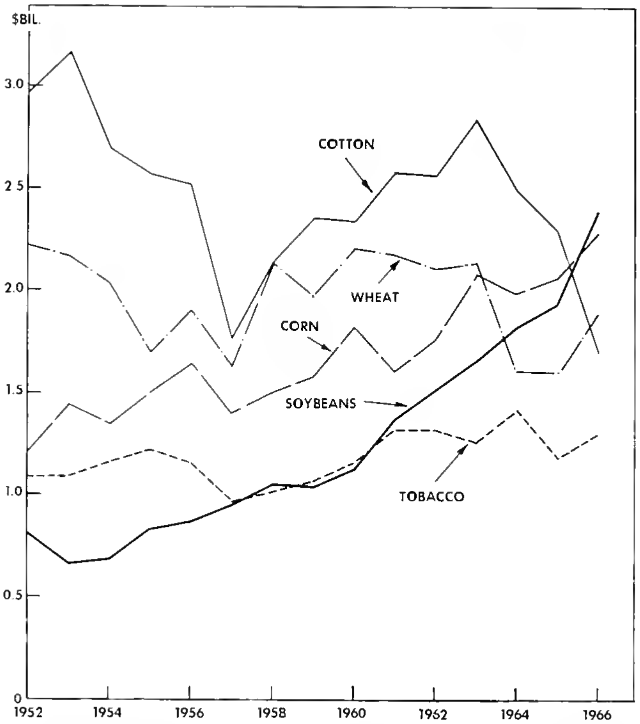
In the 1920's the University of Illinois College of Agriculture took the lead in developing and promoting the crop. Thousands of varieties were tested on the experimental farms. J. C. Hackleman and other workers encouraged farmers to grow the most promising varieties. They also helped to develop markets for soybeans and soybean products.

Illinois has ranked first in soybean production each year since records were first printed in the 1920's. By the mid-1930's Illinois was producing around 20 million bushels of soybeans, two-thirds of the national total.

In 1966 the Illinois crop was estimated at 160 million bushels, and the national crop totaled 929 million bushels.

Cash receipts from sales of soybeans were near $2.4 billion in 1966. This amount swelled the total receipts from this new crop to $24 billion.

Soybeans have proved to be a very useful crop. From them we obtain edible oil that is made into shortening, margarine, salad and cooking oils, and a protein-rich meal that is a key ingredient in most feeds for livestock and poultry. In 1966 exports of soybeans and soybean products produced $1,100 million in foreign exchange, which we needed to pay for essential products obtained from other countries and to aid the people of low-income nations. Approximately 43 percent of the 1965 soybean crop was exported as beans, oil, and meal. — *L. H. Simerl*



Cash receipts from sales of five major crops in the United States, 1952-1966.

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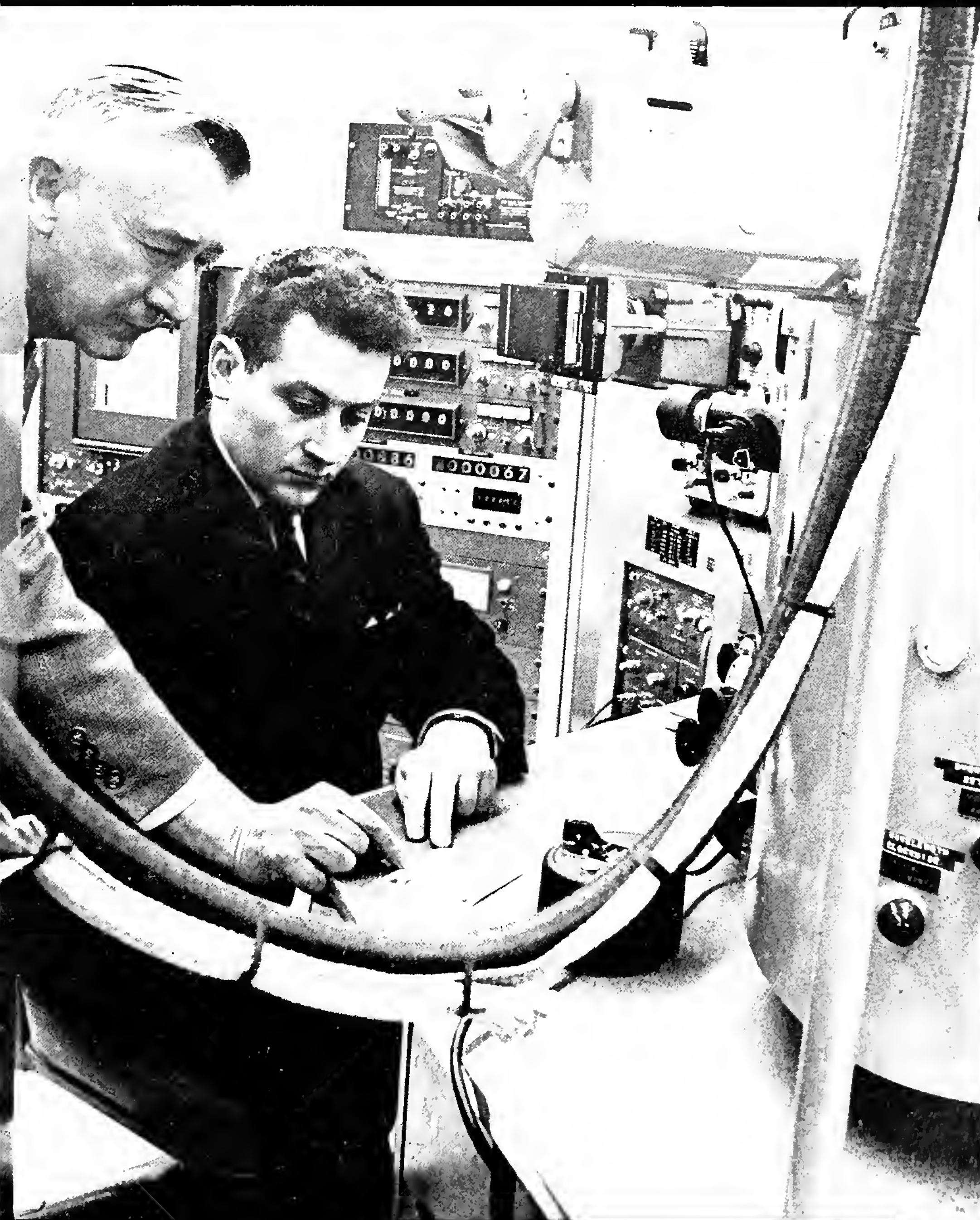

IN THIS ISSUE

The electron microprobe may provide the key to new discoveries about past climatic cycles, weathering, and the formation of soils (page 8).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell . . . . Director

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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NEWS AND VIEWS

A National Program of Research for Agriculture

DURING the first session of the 89th Congress, the Senate Committee on Appropriations recommended that the Department of Agriculture, the agricultural experiment stations of the land-grant colleges, and industry assess the present status of research in agriculture as a basis for recommendations. This challenging task was undertaken by a joint committee of the Department of Agriculture and of the National Association of State Universities and Land-Grant Colleges. Their report, "A National Program of Research for Agriculture," was issued in October, 1966. Part of this report deals with the future development of agricultural research and is summarized by these ten important objectives:

1. Insure a stable and productive agriculture for the future through wise management of natural resources.
2. Protect forests, crops, and livestock from insects, diseases, and other hazards.
3. Produce an adequate supply of farm and forest products at decreasing real production costs.
4. Expand the demand for farm and forest products by developing new and improved products and processes and enhancing product quality.
5. Improve efficiency in the marketing system.
6. Expand export markets and assist developing nations.
7. Protect consumer health and improve nutrition and well-being of the American people.
8. Assist the more than 50 million rural Americans to improve their level of living.
9. Promote community improvement including development of beauty, recreation, environment, economic opportunity, and public services.
10. Enhance the national capacity to develop and disseminate new knowledge and new or improved methodology for solving current problems or new problems that will arise.

Clearly these ten objectives challenge us to double our research efforts and to make our results readily available to our teaching and extension programs. — *Z. John Ordal, Assistant Director, Agricultural Experiment Station*

ROOT DEVELOPMENT of Corn, Soybeans, Wheat, and Meadow in Some Contrasting Illinois Soils

J. B. FEHRENBACHER, B. W. RAY, and J. D. ALEXANDER

By examining plant roots just as they grow in the soil, we can see why some soils yield so much better than others. Soils have different physical and chemical properties extending several feet deep into the profile. These differences affect the rooting pattern of plants, which in turn influences the amount and ease of nutrient and water absorption by the roots.

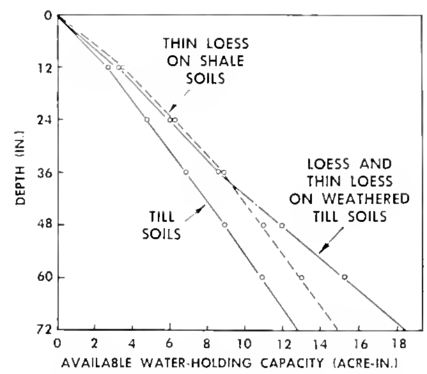
As part of our work in pedology, or soil science, we studied the rooting pattern of some common crops in a number of Illinois soils. By inserting a monolith tray (4 by 12 by 72 inches) into the soil directly under a plant, we could remove the roots and surrounding soil intact. The soil was then washed from the roots so they could be photographed and studied.

Most of the crops had been fertilized, but, when possible, rooting systems in fertilized and unfertilized soil were compared. In general, growing seasons were nearly normal, except for wet years when meadow roots were sampled in Cisne and Huey soils.

Soils studied

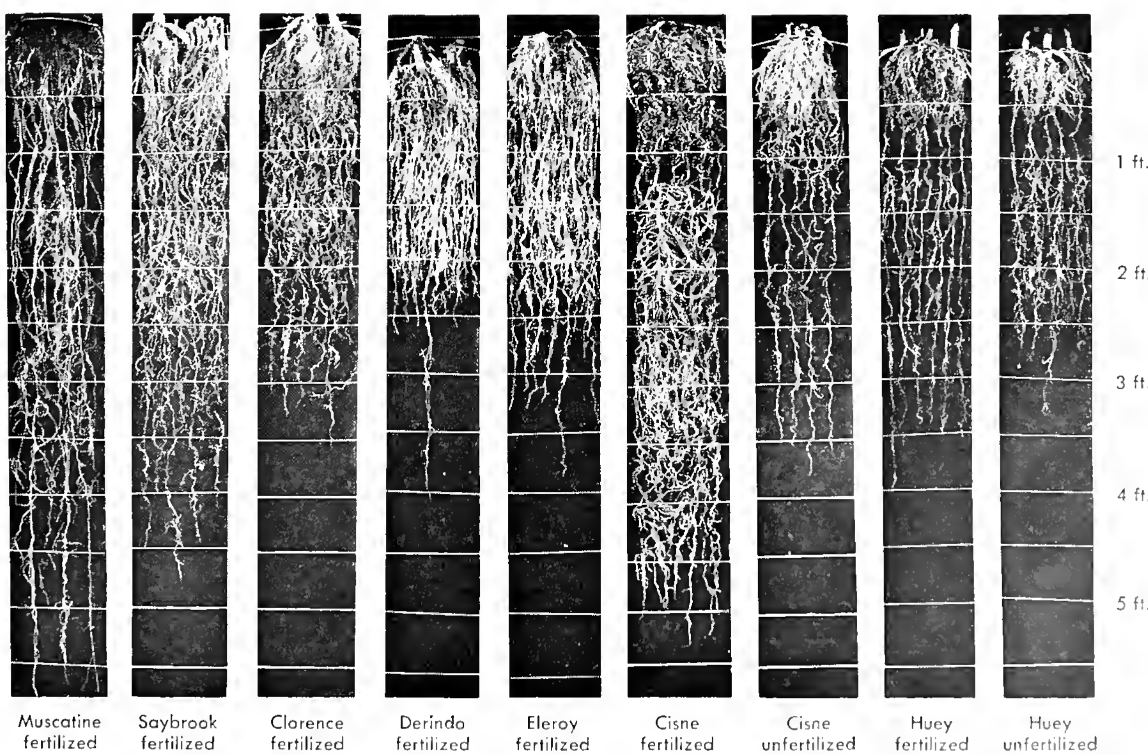
The study included soils ranging from moderately permeable, dark-colored, loess soils such as Muscatine to very slowly permeable, light-colored, high-sodium soils such as Huey. Some characteristics of the soils studied, as well as their general location, are given in the table on page 4.

Figure 1 shows cumulative water-holding capacity, with depth, for the three general groups of soils studied.



Cumulative water-holding capacity, with depth, of soil groups studied. (Fig. 1)

J. B. Fehrenbacher is Professor of Pedology, Department of Agronomy; and B. W. Ray and J. D. Alexander are both Assistant Professors of Pedology.



Penetration of corn roots in seven soil types. (Fig. 2)

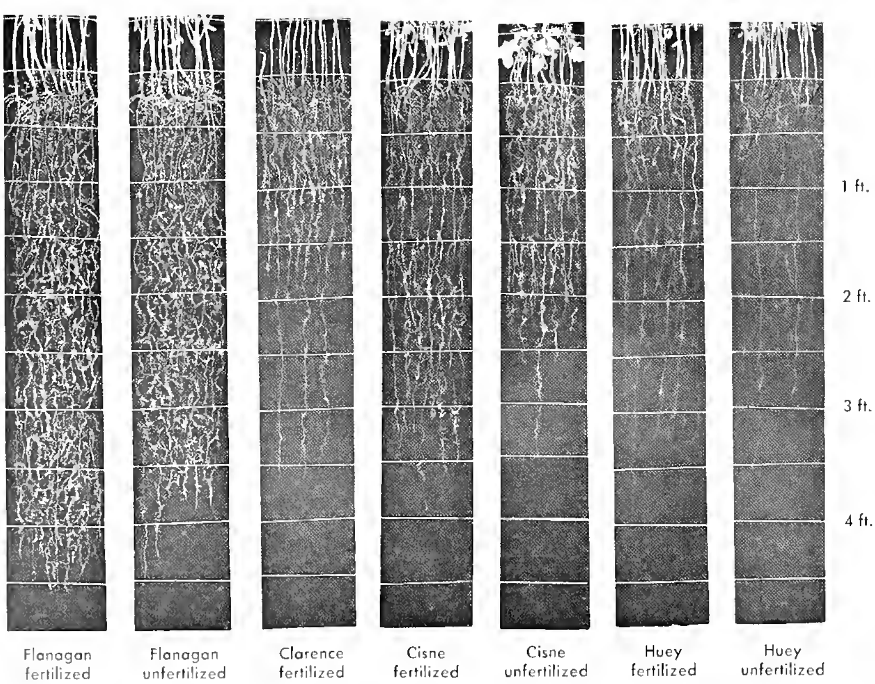
Winter and spring precipitation in Illinois is usually enough to recharge the soil profile, so that the available soil water remains fairly constant from year to year. The high water-holding capacity of the loess soils is associated with their high silt content.

How much of the available soil water can be utilized by plants depends on the depth of root penetration into the soil (Figs. 2 through 5). Comparing Figure 1 with Figures 2 through 5, we see that the soils vary widely in the amount of water that can be reached and utilized by plants. Well-distributed rainfall during the growing season is more important on soils where root penetration is shallow or rooting volume is low than on soils that permit better rooting.

Soils Included in Study: General Location and Characteristics

Soil series and general location	Parent materials	Surface		Subsoil		Natural fertility	Natural drainage
		Color	Texture	Texture	Permeability		
Muscatine and Flanagan[a] (northwestern and central Ill.)	Loess	Dark	Silt loam	Silty clay loam	Moderate	High	Imperfect
Saybrook (northeastern Ill.)	Loam till	Dark	Silt loam	Clay loam	Moderate	High	Moderately well to well
Clarence (northeastern Ill.)	Clay till	Dark	Silty clay loam	Clay	Very slow	High	Imperfect
Derinda (northwestern Ill.)	15-30″ of loess on shale	Light	Silt loam	Silty clay loam on silty clay	Moderate (very slow in shale)	Medium	Moderately well
Eleroy (northwestern Ill.)	30-50″ of loess on shale	Light	Silt loam	Silty clay loam on silty clay	Moderate (very slow in shale)	Medium	Moderately well
Cisne (south-central Ill.)	Thin loess on weathered till	Moderately dark	Silt loam	Heavy silty clay loam	Slow to very slow	Low	Poor
Huey (south-central Ill.)	Thin loess on weathered till	Light	Silt loam	Silty clay loam	Very slow	Low (high in sodium)	Poor

[a] Muscatine is developed from loess more than 60 inches thick, and Flanagon from loess 40 to 60 inches thick, over loam or silty clay loam till.



Penetration of soybean roots in four soil types. **(Fig. 3)**

Corn roots

Corn roots penetrated to nearly 72 inches in Muscatine soil (Fig. 2). The Muscatine profile has no restrictive horizon or layer. It represents one of the best root environments and one of the most productive soils in the state. Saybrook is also a productive soil, in which corn roots penetrated to about 54 inches.

Calcareous, clay glacial till occurred at about 36 inches in the Clarence soil, and calcareous, silty clay shale was found at 28 inches in the Derinda and at 40 inches in the Eleroy profile. These high clay layers, lacking well-developed soil structure, were dense and very slowly permeable. They were effective barriers to corn root penetration.

The root development in unfertilized and fertilized Cisne and Huey indicates how proper soil treatment will improve root penetration in soils that are naturally low in fertility and have claypan B horizons. The claypan begins at a depth of 16 to 20 inches in Cisne and at 10 to 12 inches in Huey. In both soils, the heaviest part of the claypan extends to 35 or 40 inches. The B horizon of Cisne has well-developed structure, and is not particularly restrictive to root penetration and branching when adequate amounts of fertilizers are applied in the plow layer.

The most restrictive layer to root branching in both Cisne and Huey is the A_2 (subsurface) horizon, which occurs below the 6- to 8-inch thick plow layer and just above the claypan B horizon. Corn roots are restricted considerably in Huey, even under well-fertilized conditions, partially because of the high sodium content of the B horizon.

Soybean roots

Root penetration and distribution of soybeans followed trends similar to those of corn. Penetration was deepest in loess soils such as Flanagan and shallowest in the high-sodium Huey (Fig. 3). Also, soybean roots did not penetrate very deeply in the fine-textured Clarence soils.

Soybeans generally do not root as deeply as corn. In the Huey soil, however, soybean roots were about as deep as corn roots. This may have been partly due to soybeans' greater tolerance for the sodium in the B horizon. The restrictive A_2 horizon in Huey and Cisne affected soybean roots much as it did corn roots.

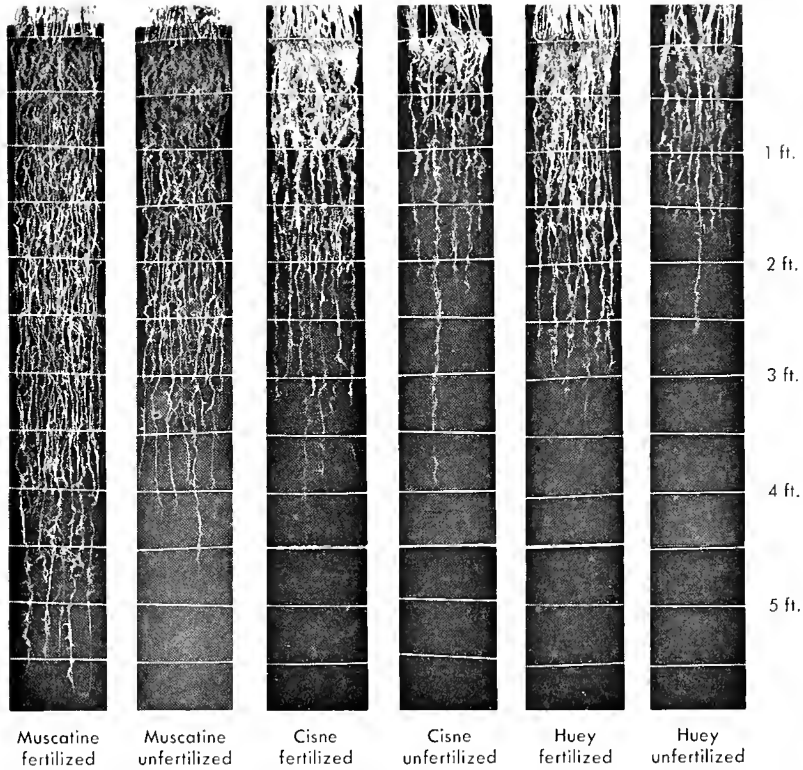
Wheat and meadow roots

Since wheat completes its growth before the hot, dry months of July and August, depth of root penetration probably is not as important as in corn and soybeans.

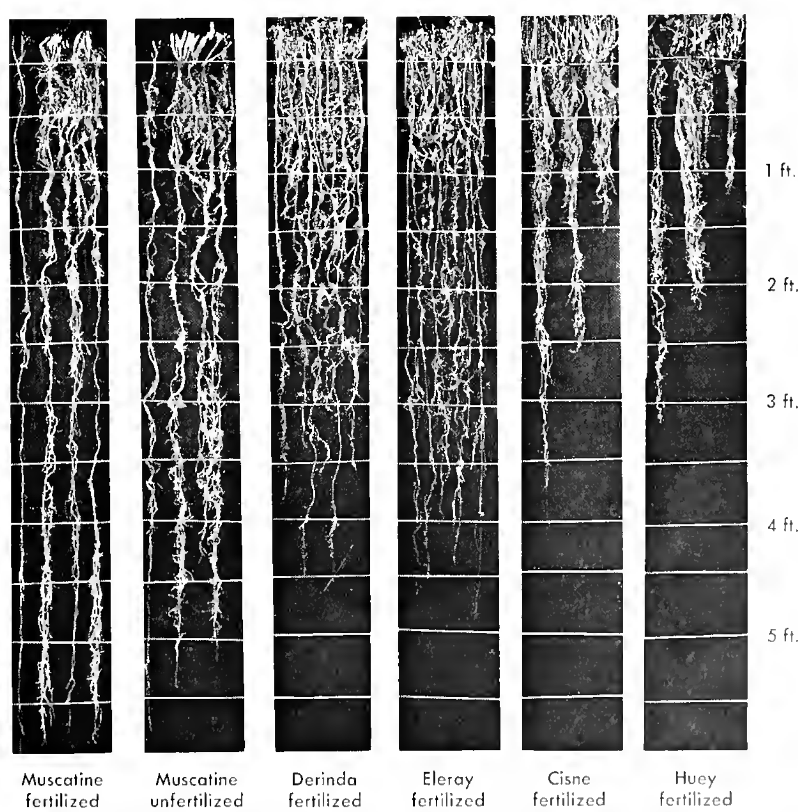
Fertilization increased the penetration of wheat roots in three soil types (Fig. 4). In Muscatine, wheat roots went almost as deep as corn roots. While not penetrating as deeply as corn in Cisne and Huey, wheat roots were better developed than corn roots in the A_2 horizon. With adequate fertilization, including nitrogen, average wheat yields are more nearly comparable on Cisne and Muscatine than are corn yields.

Alfalfa and red clover roots penetrated deeply in Muscatine, especially when fertilized (Fig. 5). In the Derinda and Eleroy, which have shale in the lower part of their profiles, alfalfa roots penetrated a foot or more deeper than corn roots. However, alfalfa roots are much more restricted in these soils than in a deep, permeable soil such as Muscatine.

Alfalfa and red clover seldom survive on unfertilized Cisne and Huey. Even with fertilization, they did not root very deeply on these poorly drained soils. Timothy also had shallow rooting systems. Meadow roots in Cisne and Huey were sampled in wet years, and might possibly be deeper in normal or dry years.



Penetration of wheat roots in three soil types. (Fig. 4)



Penetration of meadow roots. The crops shown for the five soil types are: Muscatine — one alfalfa plant (left) and three red clover plants: Derinda and Eleroy — alfalfa; Cisne and Huey — alfalfa, red clover, and timothy (from left to right). (Fig. 5)

Effects of Heredity and Prenatal Stress on Behavior of Offspring

J. C. DeFRIES

A mouse's behavior in a brightly lit "open field" indicates its response to stress. Watching the mouse are author J. C. DeFries (left), Associate Professor of Genetics, Department of Dairy Science; and Eugene A. Thomas, Laboratory Assistant.

We have all heard old wives' tales about the effects of an expectant mother's experiences upon her unborn child. According to these tales, for example, women who listen to classical music during pregnancy will have musically gifted children; those who have been badly frightened by an animal will have children with an unusual fear of animals.

Although such tales were once widely believed, it is now known that the mother's impressions cannot be directly transferred to the fetus. There are no neural connections between the mother and her unborn child. Therefore, if an expectant mother is frightened by a bear, her child is no more likely to be born with an irrational fear of bears than it is to be born with bear feet. (Of course, the possibility of bare feet should not be discounted.)

On the other hand, the fetus is not completely protected from its maternal environment. A wide variety of agents carried in the blood of the mother can cross the placental barrier and pass into the blood of the child. Various drugs, infectious diseases, hormones, and ionizing radiations affecting the mother during pregnancy can profoundly affect the physiology and morphology of the developing fetus. The malformations in children whose mothers have taken thalidomide or contracted German measles during early pregnancy provide tragic examples of the susceptibility of the fetus to its maternal environment.

There is also considerable evidence indicating that various forms of stress encountered during pregnancy may produce behavioral changes in the offspring. According to some reports, children whose mothers underwent psychological stress during pregnancy are more likely than others to be maladjusted. In addition, controlled experiments with laboratory animals have shown that prenatal stress may affect offspring behavior.

Possibility of a genetic basis

Is there a genetic basis for the way offspring respond to prenatal stress? Research relating to this question and others is being conducted by the author and Professor Morton W. Weir, of the Department of Psychology. This cooperative research in the interdisciplinary field of behavior genetics has been in progress for several years.

It would obviously be impossible to use human subjects in controlled experiments on the genetic basis for response to prenatal stress. And using large domestic animals would be expensive and time-consuming. That leaves small laboratory animals such as rats and mice. Psychologists have already developed many behavioral measures for these animals, and in addition much information is available about the genetics of the laboratory mouse. The mouse was therefore chosen as the subject for this research. It should be emphasized, however, that findings from laboratory animals do not necessarily apply to other species and that great caution must be used in extending these findings to man or large domestic animals.

The primary objective of our first experiment was to study whether the hereditary background, or genotype, of an individual has an important effect on his response to prenatal stress. In other words, do all individuals within a species respond more or less alike to prenatal stress, regardless of genotype? Or is there a difference among genotypes in susceptibility or even in the direction of the response?

A differential response among genotypes to the effects of environment is known as a genotype-environment interaction. Once such a differential response is found, its genetic basis can then be studied.

Open-field test used

In our study we employed the open-field test, a measure of behavior or "emotionality" widely used by psychologists. Animals are placed in an apparatus containing a brightly lit open area — a situation which is generally considered to cause stress.

Open areas of various shapes and sizes have been used, but they are usually small (4 to 9 square feet).

Various measures of the animal's emotionality have been used, including activity, latency, and defecation. Emotional or fearful animals tend to "freeze" and have high levels of elimination. Low activity and high defecation scores are assumed to indicate high levels of emotionality. It should be pointed out, however, that activity in the open field may also reflect such things as exploratory behavior and general activity level.

Treatment of animals

Two highly inbred strains of mice, designated BALB/cJ and C57BL/6J, were used in this experiment. Females from each strain were mated to males of the same strain so that only inbred progeny would be produced. Half of the females were subjected to several stressful experiences each day during the later stages of pregnancy. These experiences included forced swimming and being placed in strange, brightly lit compartments for a few minutes. This treatment was believed to arouse fear in the animals without hurting them physically.

The resulting offspring were given open-field tests for 2 minutes a day on 5 successive days, starting when the mice were 40 days old. The open field was circular (36 inches in diameter) and brightly lighted. From reference lines on the floor, the movement of the mouse was outlined on a small-scale map. A map measurer was later used to trace over these activity lines, giving a measure of the distance traveled.

How inbred lines compared

Offspring of treated C57BL mothers ran an average of about 30 feet per day in the open field, whereas those of control or untreated C57BL mothers ran about 36.5 feet. However, offspring of treated BALB mothers ran about 5 feet per day, compared with about 3.5 feet for offspring of control mothers. Control offspring of the C57BL strain were thus about 10 times as active as those of the BALB strain. In addition, prenatal stress affected the two strains quite differently. The difference was not just in size of the effect; the effects were in opposite directions.

Results of this experiment indicate that response to prenatal stress depends upon the genotype, since the two inbred strains are genetically different and respond differently to prenatal stress. But does this response depend upon the genotype of the mother, the fetus, or both?

Fetal and maternal genotypes

Several experiments have been subsequently conducted to measure the relative importance of the fetal and maternal genotypes in the response to prenatal stress. In these experiments, both inbred and hybrid progeny were produced. It was therefore possible to compare the effects of prenatal stress on hybrid and inbred progeny produced by mothers of the same strain and on hybrid progeny produced by mothers of different strains. Results of these experiments suggest that both the fetal and maternal genotypes are involved in the differential response to prenatal stress.

Adrenalin may possibly influence the response to prenatal stress, since stress increases the production of this hormone. Injections of adrenalin during pregnancy, however, did not reproduce the effects of physical prenatal stress.

In future experiments, the techniques of ovary and ova transplants will be employed to study different combinations of maternal and fetal genotypes. For example, ovaries from inbred females can be transplanted into hybrids. If hybrid females carrying ovaries from an inbred strain are mated to males of the same strain, inbred offspring will be produced. In this way, mothers of the hybrid genotype may produce progeny from two different strains. By holding the genotype of the mother constant and varying that of the fetus, the relative importance of the fetal and maternal genotypes in causing the differential response to prenatal stress may be examined. It is believed that a mechanism which alters fetal development so that later behavior is changed is important enough to warrant further study.

Genetics of open-field behavior

The field of psychology has been dominated by environmentalistic thinking, and the importance of heredity in determining behavior has been largely ignored. For this reason we are also currently studying the mode of inheritance of open-field behavior.

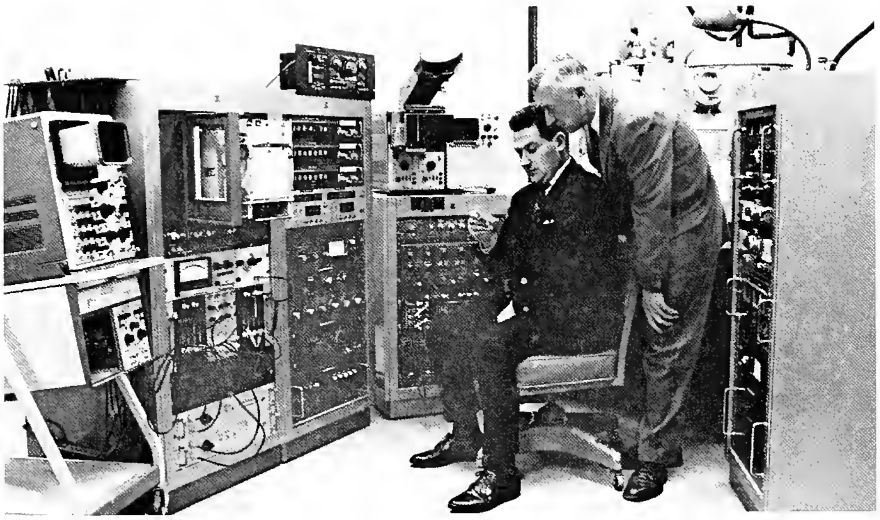
A new automated open field is being used in these studies. It is 36 inches square and is made of white Plexiglas. Two sides of the field have holes through which lights are beamed to photoconductive cells on the opposite side, dividing the floor into 36 six-inch squares. The cells are wired to counters and a timer that automatically records the number of light beams interrupted by the mouse during each test period. This apparatus increases the speed and ease of administering the open-field test.

Emotionality is heritable

Emotionality, as defined by performance in the open field, appears to be a moderately heritable trait, indicating the importance of both genotype and environment. Results of recent experiments demonstrate that many genes influence this behavior, although one gene appears to have a major effect.

Albino mice have consistently lower activity and higher elimination scores than non-albino or pigmented animals. When light intensity is reduced during testing, however, this difference largely disappears. This indicates that albinos are more "photophobic" or fearful of light than normally pigmented animals.

Since this research has been conducted with mice, the results are not immediately applicable to man or large domestic animals. However, these results do add to the relatively meager store of information available about the inheritance of behavioral traits.



Authors Michel P. Cescas (seated), Research Assistant in Soil Fertility, and Edward H. Tyner, Professor of Soil Fertility, with the electron microprobe. The power source is at far right of picture; the actual probe is behind the authors; and the readout system, including a polaroid camera, is at left. (Fig. 1)

Chemical Analysis of Soil Particles

A new approach to the study of climatic cycles, weathering, and soil formation

MICHEL P. CESCAS and EDWARD H. TYNER

A WHOLE new world is opening up in the study of soils, thanks to a recently developed instrument known as the electron microprobe analyzer. This instrument makes it possible to study the chemical composition of a very minute soil particle, just as the electron microscope has already made it possible to study a soil particle's physical structure.

How the instrument works

The electron microprobe analyzer, initially conceived in 1947, was primarily developed in France by Castaing and Guinier after 1949. It has many features in common with the electron microscope. The generation of the electron beam is similar, but the electromagnetic optic system permits a beam focus on a sample or target area of 0.75 to 2 microns (a micron is 0.000039 inch).

As the highly energetic electrons hit the target, they cause the emission of X-rays characteristic of the elements in the target. The emitted X-rays pass through a detector system and the resulting signals can be displayed on several types of readout systems. From these systems we can determine the kinds and amounts of elements present in a soil particle. Elements down to boron (with an atomic number of 5) can be detected. The electron probe at the University can accept three detector systems, permitting the simultaneous analysis of three elements.

Along with X-ray emissions, backscattered electrons are emitted, detected, and displayed on readout systems. The difference in measured intensity of electron backscattering (Fig. 2A) reflects differences in atomic number of the elements in the sample matrix. The electron backscattering reveals the chemical homogeneity of the sample and helps pinpoint areas of particular interest.

The early instruments used static probes, but present instruments are designed with scanning probes. As the electron beam automatically sweeps across a stationary sample, it shows the general distribution of an element in the sample. An X-ray intensity line scan, showing point-by-point composition can also be obtained and graphically superimposed on the X-ray intensity sweep pattern. Quantitative analysis is made by comparing the intensity of the emitted X-rays with standards of known composition.

Composition of a concretion

The sample used in Figure 2 was an iron-manganese concretion about the size of a grain of sand, taken from the Morrow Plots. The variable density of the backscattered electrons (Fig. 2A) indicates that the chemical composition is not uniform. This has been true for all concretions examined.

A rather uniform but low silicon content is indicated by the X-ray intensity sweep and line scan in Figure 2B. The silicon is probably associated with clay and silicate minerals uniformly distributed through the concretion.

The X-ray intensity sweeps and line scans for iron and manganese (Fig. 2C and D) indicate that the iron content is very high in the core section whereas manganese dominates the outer shell. The zoning of iron and manganese was not expected. Even more surprising, however, is the fact that the maximum concentrations of iron and manganese are not in phase — that is, they do not coincide.

Other concretions analyzed have shown zoning of these two elements, but the lack of phase in the maximum concentrations is not always so pronounced as is the concretion illustrated. Some concretions have more zones of concentration than are shown in Figure 2, suggesting that perhaps not all concretions in a given soil horizon were formed at the same time.

A possible explanation

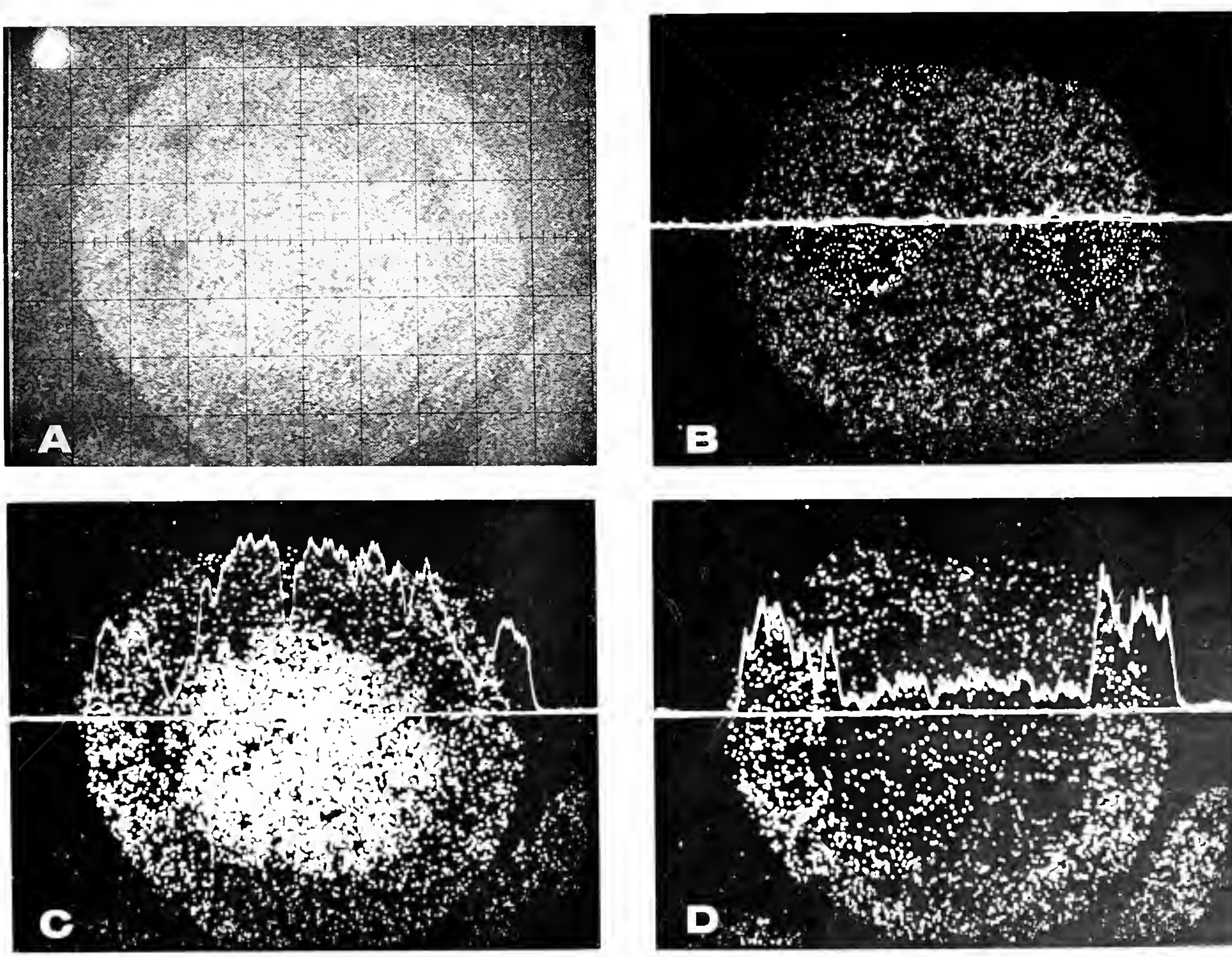
How can we account for the distribution of iron and manganese in the concretions? How did the zones develop? Why are the zones of maximum concentration more out of phase in some concretions than in others? These questions lead to the basic one of how the iron and manganese may initially have been solubilized.

Both of these elements are subject to oxidation-reduction reactions and are quite water-soluble in their reduced form. Their reduction and solubilization would be favored by periods of unusual wetness or high rainfall. However, manganese becomes soluble in a less reducing environment than iron, and can therefore move quite independently of iron. If the soil environment is such as to reduce iron, then manganese is reduced at the same time, but manganese is usually precipitated after iron.

Oxidation-reduction reactions could thus explain the zonal composition of the concretions and also the lack of phase in the maximum concentrations of iron and manganese. Implicit in such an explanation is the suggestion that alternate cycles of oxidation and reduction have occurred in the past. This is conceivable, since world-wide climatic fluctuations in the post-glacial era have been suggested by lake-cycle chronology and pollen profiles in non-glaciated regions, and by recent changes in sea levels. It is therefore possible that the iron and manganese chemistry of concretions reflects these past climatic fluctuations.

If further work proves the truth of this hypothesis, it might be possible to analyze soil concretions with the electron microprobe analyzer and deduce the number of past climatic cycles, their duration, and the intensity of weathering accompanying each cycle. Soil scientists would then have a powerful tool for peering into past processes causing present-day differences in soil features and behavior.

The authors wish to thank Dr. C. A. Wert of the College of Engineering for making the electron probe facilities available, and L. J. Gray and F. J. Luehrs of the Materials Research Laboratory for assistance in the operation of the electron probe. The project was supported in part by Atomic Energy Commission Contract No. 1198.



Microprobe analysis of a concretion about 300 microns (0.01 inch) in diameter. Electron backscattering is shown in A. The other pictures are X-ray intensity and line scan profiles for silicon (B), iron (C), and manganese (D). (Fig. 2)

Controlling the Size of Apple Trees

ROY K. SIMONS

Some problems and limitations of the East Malling VII rootstock

CONTROLLING the size of apple trees has become essential for the successful production of fruit with limited labor. Small trees are adapted both for "pick your own" type of labor and for mechanical harvesting.

According to the Illinois Crop Reporting Service, 66,000 apple trees were growing on dwarfing rootstocks in this state in 1962. Since then, interest has been increasing in compact trees, particularly the "spur types."

Illinois growers have problems

Many Illinois growers are using East Malling VII dwarfing rootstock. Although this rootstock has been satisfactory in other apple-growing regions, both in the United States and in Europe, its performance in Illinois has been variable and, on the whole, not highly successful.

Orchardists in southern Illinois have had more difficulty with this rootstock than those in the northern part of the state. As an example of the southern orchardist's problems, about 25 percent of 715 trees have died in one 10-year-old orchard of Golden Delicious on EM VII. In another block of 440 Golden Delicious on EM VII, 17 percent of the trees were dead after 4 years of growth. Adjacent to this block, 13 percent of Starking on EM VII were also dead after 4 years.

Trees on EM VII stock may not always produce a quality crop. As illustrated in Figure 1, there may not be enough leaves to manufacture the carbohydrates needed for high-quality fruit. Also, without adequate leaf protection during hot weather, fruit may develop tissue burn, commonly called "buckskin." Although the EM VII tree pictured in Figure 1 did not produce high-quality fruit, it did produce quantity. The commercial orchard in which it was growing averaged 6 bushels of fruit per tree.

Roy K. Simons is Professor of Pomology, Department of Horticulture.

Some weaknesses studied

Sometimes even though a full crop of fruit is formed, the tree dies before the apples mature. This may be due to incomplete union of tissues in the graft area, which in turn interferes with the flow of water and nutrients in the tree. In Figure 2 (left) we see a longitudinal section through the graft-union area of a 3-year-old Golden Delicious on EM VII. This can be compared with a longitudinal section through a healthy tree on a seedling stock (Fig. 2 right).

Tissue incompatibility in the graft-union area of a dying 5-year-old Golden Delicious on EM VII rootstock is illustrated in Figure 3. Malformations in the root system of the same tree are shown in Figure 4. Proliferation of lateral roots produce "burr knots," which, in turn, result in inclusions of dead tissue throughout the conducting tissue.

As the malfunction at the graft-union area continues into the trunk, it causes twisting, often to an extreme degree (Fig. 5). A sample of bark tissue showing normal characteristics was taken about 1 foot above the graft-union area of a twisted tree, while another sample was taken from the depressed area.

Tangential sections from the phloem tissue (main conducting tissue from leaves to roots) of these two samples are shown in Figure 6. Necrosis or dying of the tissue, as well as a decrease in the size of the functioning phloem cells, is revealed in the bark from the depressed area. As growth stress was increased, more necrosis was found in the phloem-ray cells, and the tissues eventually died.

Experiments going on

Experiments are now being conducted at Urbana to find possible ways of overcoming some of the difficulties connected with EM VII. Effects of variety, mulching method, and systematically varied irrigation are being studied with Golden Delicious, Starking, and Jonared on replicated plots.

After 6 years, about 6 percent of the original 540 trees have died. Among those that survived, mulching and irrigation, singly or together, have improved uniformity and have increased tree size by about 20 percent.

Management recommendations

On the basis of experimental results, the following suggestions are made for managing EM VII rootstock:

- Establish a mulching program during the first year's growth, or combine mulching with irrigation during periods of drouth. A mulching program will not only increase tree growth but will protect the shallow roots from freezing temperatures.
- Stake trees early. Because the root system of the EM VII stock is shallow, unsupported trees may blow over during severe windstorms.
- Remove the large amount of suckers around the base of the tree.
- Remove any lateral shoots that may arise on the tree trunk near the graft union.

Two 10-year-old Golden Delicious trees. Top tree is growing on EM VII rootstock; lower tree, on seedling stock. Note sparse leaves on EM VII tree. (Fig. 1)

Longitudinal section through the graft-union area of a 3-year-old Golden Delicious on EM VII stock (left) and through a healthy tree on seedling stock. (Fig. 2)

Longitudinal section through the graft-union area of a dying 5-year-old Golden Delicious on EM VII stock. Roots of the same tree are shown below. (Fig. 3)

Malformed roots from the same EM VII tree shown in Figure 3. (Fig. 4)

Twisted trunks often result from malfunction at the graft union area. (Fig. 5)

Tangential sections from the phloem tissue of two bark samples from a twisted EM VII tree. Left, normal bark; right, bark from a depressed area. (Fig. 6)

FAMILY GOALS AND USE OF RESOURCES

in Different Stages of the Family Life Cycle

JEANNE L. HAFSTROM and MARILYN M. DUNSING

WHERE does the family's money go? Is it spent according to a well thought-out plan? Or is it spent haphazardly to satisfy spur-of-the-moment desires for goods and services?

Information obtained from the Illinois Family Account Project helps us to understand how families in Illinois allocate their incomes to reach their goals. Both urban and rural families participate in the project by recording annual income and expenditures in the Illinois Family Account Book and sending it to the Department of Home Economics. This project is the only one in the United States that has obtained income and expenditure records for over 35 years from a group of fairly homogeneous families.

Most families participating in the project list their goals in their account books at the beginning of each year. By looking through their records it is possible to see which goals are met during the current year and which ones are put off to the future. In addition, we can see which long-time goals are met through the years, which are modified, and which are discarded.

What are family goals?

Family goals are obviously different for each family, since no two families have the same needs and wants. In general, a goal may be thought of as an objective that a family strives to attain, whether next month or 20 years from now.

Short-term goals include things that a family wants or needs soon, such as this month or next. They may include buying a new tire for the automobile, for example, purchasing a new coat for one of the children, or paying each bill when it is due.

Intermediary-term goals are those that a family wants to attain in the near future, perhaps during the next year or two. They might include purchasing a new refrigerator or automobile, landscaping the yard, paying off current installment debts, or saving for a rainy day.

Long-term goals are the things the family may need or want within the next 5, 10, or even 20 years. Perhaps the family wants to buy a house or pay off the mortgage on the farm; provide for family income in case of the disability or death of the breadwinner; add a room to the house; send the children to college; or take a trip to Europe.

What are family resources?

Family resources include not only money, material goods, and credit, but also the abilities and skills of family members, time, and community facilities available to the family. Of the families that participate in the Illinois Family Account Project, some have relatively little money, but they use the skills of family members to advantage. Other families that have more money appear to purchase more of their goods and services.

The success of any family's financial program is closely tied to its skill in combining its resources so that the family will attain as many goals as possible.

Goals and the family life cycle

Although goals and resources are different for each family, data from the research project indicate that goals tend to be similar for different families in the same stage of the family life cycle. Seven such stages are generally recognized. Stage 1 is the period during which the family is being established; stage 2, the child-bearing and preschool period; stage 3, the elementary school period; and stage 4, the high school period. If the family sends the children to college, it goes through stage 5, the college period. Stage 6 is the recovery period, which is characterized by the economic independence of the children, and stage 7 is the retirement period.

Throughout the family life cycle the economic needs of the family reflect the changes in its size, composition, and income, as well as the development and aging of family members.

With this background on family resources, goals, and the family life cycle, let's examine the goals of families that participate in the Illinois Family Account Research Project.

Stage 1 — establishment of the family. Young families without children listed such short- and intermediary-term goals as the following: finish furnishing the house, make a comfortable living, take a vacation, have the wife get her B.S. degree, keep better records, and buy a car. Long-time goals included buying a farm, saving money for retirement, increasing net worth, and having money for children.

The family account records showed that many of the families were, in fact, working to reach their shorter term goals. One wife was paying tuition and buying books for her college education. Purchases of furniture, refrigerators, and automobiles, as well as vacation expenses, were found in the records of other families.

Additions to savings would indi-

Jeanne L. Hafstrom is Instructor in Family Economics, and Marilyn M. Dunsing is Professor of Family Economics, both in the Department of Home Economics.

cate that the families were working to attain their long-term goals. However, the records did not show that families were doing this while in the first stage of the family cycle.

Stage 2 — child-bearing and preschool. As children are born into the family, both short- and long-term goals reflect the change in the family's status. At this stage many families listed a new washer, a clothes dryer, more farm equipment, and insurance as immediate needs. Their long-term goals included saving money for the children's education, putting up a yard fence, buying a house, and having more children. One family indicated that it wanted to lead a reasonably comfortable life in terms of material things.

Many of these young families were using credit to meet their short-term goals. Few of them were saving money for the long-term goals they had listed.

Stages 3 and 4 — elementary and high school. The goals of families with children in elementary and high school tend to reflect their changing needs. For example, several of these families indicated that a larger house was needed, or that a new room, such as a family or recreation room, should be added to their present house. Others included remodeling of kitchen or bathroom among their long-term goals.

Many farm families wanted to increase the size of the farm, buy more cattle, or pay off the farm debt. One couple said that they wanted to make farming an attractive enterprise to their children. Saving for the children's college education was another long-term goal held by many families. The records show that some of these families were actually saving on a regular basis for the college education; some were using endowment insurance; while others were paying off their debts at a faster rate than they had in previous years.

By following the records of the same families over a five-year period, we see that many of them achieved at least some of their intermediary- and long-term goals. For example, expenditures were recorded for new furniture, for making the basement into a recreation room, and for remodeling other rooms. Also, "final payment made" was sometimes written after a series of mortgage or car payments.

Stage 5 — the college period. Among families with children in college, short- and intermediary-term goals included completion of the children's education, keeping up insurance payments, repairing the water system, and making wise use of available income. As examples of long-term goals, some families wanted to repay borrowed money; others wanted to have more leisure time, install a barn cleaner, replace the combine and picker, acquire more acreage, or buy a new car.

Stage 6 — the recovery period. It is interesting to note the change in a family's economic goals after the children are grown and are earning their own living. A western vacation and a trip to Europe were among the goals of families in stage 6. Some families wanted to finish paying for their farms — others mentioned saving for a comfortable retirement. Among the things they wanted to buy in the fairly near future were a stereo record player, new household furnishings or appliances, income-producing property, and a lot in Florida.

Stage 7 — the retirement period. After retirement, families or individuals listed such goals as maintaining the present level of living, buying furniture, providing for health care, providing an inheritance for the children, and helping married children to build up their properties.

Over a period of years, the records of these families show how many of the goals were attained. Some retired individuals gave money directly to children or grandchildren, while others deeded property to them or bought paid-up insurance for them. Many of the families did purchase new furnishings and equipment while others recorded extensive travel expenses for the first time in their lives.

Some general comments

While we have listed goals of families in each stage of the family life cycle, it should be pointed out that families may be in two or more periods at the same time. They may be retired and still have children in college, for example, or they may have children in both grade school and high school. Their goals will of course reflect this dichotomy.

Emergencies may sometimes force families to put off short-term goals until a later time. For example, a family that planned to buy a better car and a new washer in 1966 did not do so. Its records showed a series of bills for furnace repairs which ended when a new furnace was purchased in December.

As mentioned earlier, some families are very skillful at combining resources to reach their goals. One farm family wanted more leisure for the husband and a town family wanted to be free of debts. Both families achieved these long-term goals by the same method — the wives secured employment outside the home. The farm family used the added income to pay a hired man and thus provide more leisure time for the husband. The urban wife's income helped to pay off a large debt accumulated over many years.

Many families have reported that the use of family account records helps them to plan more realistically for future expenditures. They feel they have attained their economic goals sooner than they would have otherwise. Recording current expenditures helps the family to see how money is being spent and where expenditures may be cut if necessary. A family can compare its records with those of other families participating in the Illinois Family Account Project to see how they differ and where they are similar.

Any interested family may participate in the project. All that is necessary is to fill out the Family Account Book for an entire year (January 1 through December 31) and send it to the Department of Home Economics, University of Illinois.

Veterinary Medicine in India

PAUL D. BEAMER

One of the responsibilities of the University of Illinois is to provide technical advice and assistance for agricultural universities in the states of Uttar Pradesh and Madhya Pradesh in India. The University fulfills this responsibility under a contract with the Agency for International Development, the contract being based on an agreement between the Indian and U.S. governments. Dr. Beamer, who is Professor of Veterinary Pathology and Hygiene and of Veterinary Research, served as adviser to the Dean of the College of Veterinary Medicine, Uttar Pradesh University, from 1960 to 1964.

Since ancient times, the art of veterinary medicine has been practiced in India. Veterinary hospitals were established as early as 250 B.C. Long before then, possibly as far back as 2300 B.C., references to the treatment of animal diseases were made in the Vedas or Hindu sacred writings.

After the Mogul invasions about 1000 A.D., Indian culture declined. Little progress was made in veterinary medicine until the third decade of the nineteenth century, when the British, primarily concerned with the wounds and diseases of military animals, established the Army Veterinary School at Poona.

By now there are 18 colleges of veterinary medicine in India. Nearly every sizable community has a veterinary hospital, while large cities may have two or more.

The livestock situation

In 1963 India was estimated to have 175,272,000 cattle and 51,137,000 buffaloes — or about one head of cattle or buffalo for every two people. Many cows produce little or no milk, their contribution to the economy consisting only of dung for fertilizer or fuel. Dung production cannot be discounted as it provides the only fuel for many people.

The Indian cultivator depends almost entirely on bullocks or buffaloes to till his fields and to harvest and market his produce. He must maintain an excess of bullocks to insure against the threat of loss of cattle power through disease or accident. Such a loss at planting or harvest would cause extreme hardship or even famine.

Indian livestock are very poorly nourished. Many cattle subsist on waste grasses growing on roadsides, ditch banks, and other uncultivated areas. During the dry season the supply of forage becomes practically nonexistent. Because of the demand for human food, no substantial acreage can be diverted to the production of animal food.

The problem of too many poor cattle cannot be solved by slaughter, since this is opposed by the vast majority of Indians. Recent demonstrations in New Delhi and elsewhere represent an effort to force the banning of cow slaughter throughout the country.

While difficult, the problem of cattle population need not be insoluble. A partial solution would be to provide better nutrition for cattle of higher production potential and to protect them from devastating infectious diseases. Large numbers of low-grade cattle could then be replaced by fewer improved cattle.

Practice of veterinary medicine

The practice of veterinary medicine is almost entirely supported and controlled by the government. The veterinary hospitals in the larger communities serve the villagers and farmers of the area as well as local townspeople.

By American standards the hospitals, with few exceptions, lack adequate equipment, staff, or money. Modern drugs are scarce or unobtainable. When they are available, they are prohibitively expensive.

While hospitals in large cities may be adequately staffed, those in smaller communities are usually staffed by one trained veterinarian, one compounder, two animal caretakers, and a sweeper. The veterinarian is responsible for the health and vaccination programs of many thousands of animals, often to a distance of 20 miles or more from his hospital. He travels by bicycle, bus, or commercial truck.

Field duties may occupy the veterinarian for several days at a time. Animals brought to the hospital during his absence are treated by the caretakers and compounder. It is understandable that most animals receive inadequate medical care.

Despite their handicaps, Indian veterinary hospitals provide a very real service to their communities. By following extensive vaccination programs, veterinarians are reducing the ravages of infectious animal diseases.

Even so, rinderpest, foot and mouth disease, pox diseases, and parasitic diseases continue to kill or incapacitate large numbers of livestock every year. Other diseases exact a somewhat lesser toll. Curiously, two devastating cattle diseases of Europe and America, tuberculosis and brucellosis, appear not to be, or are not recognized to be, of major importance in India.

Veterinary training

Veterinary training is quite different in India than in the United States. Indian tradition follows that of the United Kingdom and other European countries by combining veterinary medicine and animal husbandry. On completing the four-year curriculum, a student receives

the degree of Bachelor of Veterinary Science and Animal Husbandry. People trained in this area have traditionally had inadequate communication with those trained in agricultural science, which in India really means plant science.

This lack of communication keeps both groups from appreciating their common problems, and impedes progress in the scientific production of foodstuffs. Indians concerned with food production vigorously debate whether animal science as a discipline should remain a part of the veterinary curriculum, should be offered as a separate curriculum in colleges of veterinary medicine, or be offered in colleges of agriculture as in the United States.

Indian students entering veterinary colleges are generally several years younger than their American counterparts, and are usually less well grounded in mathematics, chemistry, and physics. Deficiencies in these subjects have to be corrected during the four-year veterinary course. In addition, the curriculum includes English, Hindi, economics, sociology, and sometimes other humanities. The time spent on these important but non-medical studies in India is mostly devoted to clinical studies and practices in American veterinary colleges. As a result Indian students are less well prepared in clinical veterinary medicine than are American students.

Since India's major veterinary effort is directed at controlling the great animal plagues, veterinary curricula emphasize the basic medical sciences including anatomy, physiology, microbiology, and pathology. Instruction in these disciplines has been hampered by too little laboratory equipment and study material. In many colleges for example, several students may share one microscope and one set of study slides. Microscopes and other scientific instruments are now being manufactured or assembled in India, however, so that more teaching equipment is becoming available.

Another hampering influence has been the requirement that teachers rigidly follow prepared syllabi for all courses. Now, however, larger numbers of better trained teachers have reduced the need for prepared syllabi. As the instructor is permitted greater latitude in presenting his material, he is encouraged to keep abreast of new methods of disease control and research.


A cattle sale in India.

American universities are models

Soon after India won her independence, the University Education Commission, appointed by the Indian government, recommended that India establish rural educational institutions patterned after the land-grant colleges of America. Seven such rural universities are now developing. Their objectives are to provide educational opportunity for the people of rural India; to conduct research on food-production problems; and to develop an agricultural extension service that will carry the results of education and research to the Indian cultivator.

Under a contract with the Agency for International Development, the University of Illinois is giving technical aid to agricultural universities in two Indian states. These universities cover the entire range of agriculture including veterinary medicine. Many Illinois staff members have worked at the Indian universities, and members of the Indian faculties have come to Illinois for advanced study. As a result, veterinary curricula are being revised and graduate study programs are being developed in many schools.

As efforts to increase the value of livestock are successful, this important national resource will need to be safeguarded by better clinical facilities and by men thoroughly trained in clinical medicine. Many Indian veterinary colleges are preparing to meet the challenge. Increasing numbers of Indian veterinarians are going abroad for postgraduate study. X-ray equipment is being installed in the colleges and clinical facilities are being improved.

Most colleges also have functioning or proposed ambulatory clinics which carry students to field stations where animals are regularly brought for treatment by their owners. These ambulatory clinics give the student a variety of animals and disease conditions for study and treatment and, equally important, they demonstrate to the cultivator the economic and humanitarian value of accurate diagnosis and effective early treatment.

Public health measures

The strength and welfare of a nation depends on the health of its people. Control and prevention of animal diseases transmissible to man and assurance of wholesome food products from healthy animals are the responsibility of veterinary public health activities. All veterinary curricula in India now include courses in meat hygiene, milk hygiene, and processing of food of animal origin. Veterinarians are employed as food inspectors at major meat and milk-processing plants. Veterinarians are also employed in applying public health principles and in research.

India has a great need for well-qualified veterinarians. Substantial progress has been made toward training men to meet that need. Much remains to be accomplished.

FOREST INSECTS: Their Location and Seriousness in Illinois in 1966

R. G. RENNELS

EVERY YEAR since 1961 the University of Illinois Department of Forestry has been putting together a pretty good picture of the location and seriousness of major forest insect pests in Illinois.

This has been done with the help of carefully selected cooperators throughout the state. Each cooperator has received a supply of cards on which he can record pertinent information whenever he observes an insect infestation. This information includes the name of the insect (if known), host species, location of the infestation, and its apparent seriousness. If the cooperator cannot positively identify the insect he is asked to send in a specimen along with his report. The specimens are identified by Dr. Herbert Ross and his associates at the Illinois Natural History Survey.

The information submitted by the field cooperators is tabulated and summarized for each year. The summaries, together with my own statewide observations and comments, have constituted the annual forest insect situation reports.

Situation not bad in 1966

Although the 1966 report indicates that a few of our most destructive insects are rising in number, most species remained at the level usual for this region. For the first time in several years, forest plantings in many areas of the state were damaged more by drouth than by insects. The insects causing the most trouble last year were defoliators and terminal feeders.

Important defoliators

Pine sawflies. The European pine sawfly (*Neodiprion sertifer* (Geoff.)) was the insect most frequently reported (Figs. 1 and 2). Not only was it found in more plantations than in past years, but damaging populations were encountered more frequently. Some plantations were sprayed with virus solution and others with chemical insecticides. Virus spray kills larvae so slowly and erratically that chemicals must be used to control heavy infestations in Christmas tree plantations.

In addition to the European pine sawfly, I observed two other pine sawflies in the field in 1966 — the Virginia pine sawfly (*N. pratti pratti* (Dyar)) and the white pine sawfly (*N. pinetum* (Nort.)). The loblolly pine sawfly and the red-headed pine sawfly were apparently present only in very small numbers.

Bagworm (*Thyridopteryx ephemeraeformis* (Haw.)). Bagworms continued to occur in many plantations, although no reports of increasing populations were received.

Important terminal feeders

European pine shoot moth (*Rhyacionia buoliana* (Schiff.)). This is potentially one of the most serious enemies of pine Christmas trees (Figs. 1 and 3). Although it wasn't reported in any more plantations in 1966 than in past years, population levels were higher this year in the infested plantations that were examined. This year marked the first major increase in the population of this species since its very low ebb after the severe winter of 1962-63.

Zimmerman pine moth (*Dioryctria zimmermani* (Grote)). A tip feeder, the Zimmerman pine moth operates in about the same micro-habitat as the European pine shoot moth (Fig. 4). According to field examinations, this species also was more prevalent in 1966 than in 1965 (Fig. 1).

Nantucket pine tip moth (*Rhyacionia frustrana* (Comst.)). The status of this moth remained unchanged with one possible exception: Larvae from Scotch pine tips in a Christmas tree plantation in Ogle county were identified as belonging to this species. Ogle county is north of this moth's usual range, however, and the habits displayed by the larvae and the nature of the damage were not typical for the species. Investigations in 1967 should clear up the identity of the moth involved in this infestation.

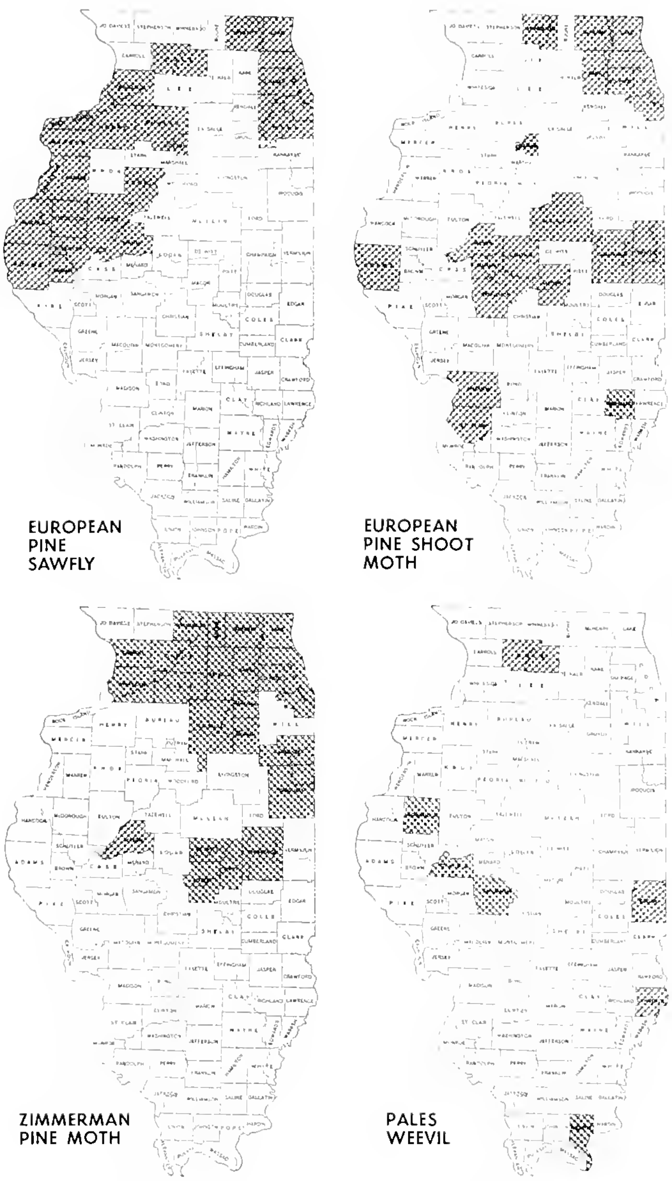
Pales weevil (*Hylobius pales* (Hbst.)). This species continues to present a serious problem to some Christmas tree growers in scattered areas throughout the state (Fig. 4). After the 1966 Christmas tree harvest, some stumps had to be treated to prevent serious adult feeding damage this year.

Insects of minor importance

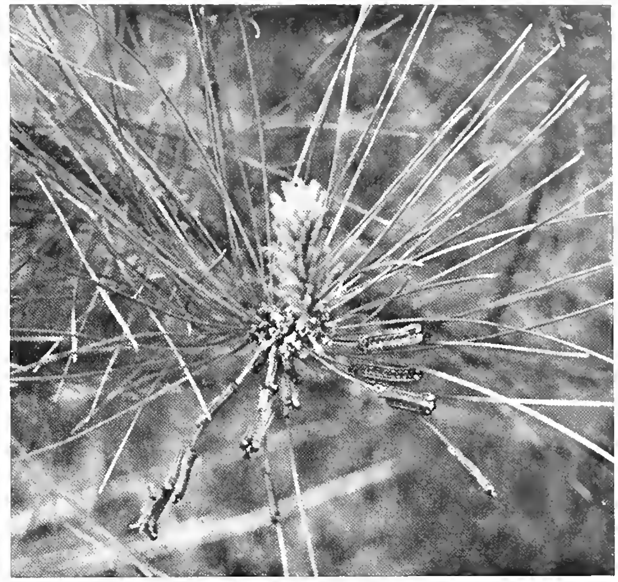
Insects generally of minor importance were reported fewer times in 1966 than in any of the preceding five years. Possibly cooperators failed to observe small populations of insects causing minor damage, or they neglected to report all such sightings. The small number reported does not indicate the disappearance or eradication of any minor species from the forest environment.

Large numbers of the northern pine weevil, *Pissodes approximatus* Hopk., were found in a few Christmas tree plantations in the northern part of the state. Although branch flagging from adult feeding injury has not been observed, this insect should be watched carefully, especially in large Christmas tree plantations in extreme northern Illinois.

Although field cooperators did not



Counties in which the European pine sawfly, European pine shoot moth, Zimmerman pine moth, and pales weevil were observed from 1961 through 1966. (Fig. 1)



European pine sawfly larvae on red pine. (Fig. 2)

Resin-covered red pine buds infested with larvae of the European pine shoot moth. (Fig. 3)

Zimmerman pine moth larva in Scotch pine shoot. (Fig. 4)

report the pine needle scale, *Phenacaspis pinifoliae* (Fitch), I observed it in a number of plantations. This species should be watched every year.

Two reports of *Ips* species were received. In one plantation they were associated with a few dying red pines, but the circumstances did not suggest that they were the major cause of the trees' death. *Ips* species have been a problem in some of the northeastern states and should be watched in Illinois.

The solitary sawfly, *Diprion frutetorum* (Fabr.), was encountered in Scotch and red pine plantations in the northern third of Illinois. Populations continued to be low.

Monoctinus spp., a juniper sawfly that is normally very rare, occurred in outbreak numbers in a single ornamental nursery in northern Illinois. Several varieties of junipers were completely defoliated. Because few junipers are planted for reforestation purposes, this insect, although interesting, will probably never be a major concern of forest land owners.

Reports will continue

Annual surveillance and reporting of forest insects will continue. Through the combined efforts of many capable observers, we hope to achieve the best possible statewide view of the forest insect situation in Illinois.

R. G. Rennels is Associate Professor of Forestry.

Extension Helps Communities to Study and Cope With Problems of Economic Growth

H. J. SCHWEITZER and L. P. FETTIG

UNEVEN economic and social development is a persistent characteristic of economic growth. It is likewise a persistent challenge to Illinois citizens. Primary concerns are to develop and maintain a good physical and social environment, and to give each individual the opportunity of realizing his potential contribution to himself and to society.

These concerns encompass many problems. A partial list would include urban congestion and sprawl into the countryside, water and air pollution, problems of supplying economic and social services to areas which either are growing very rapidly or are declining in population, and problems of poverty. It is unrealistic to hope that all or perhaps any of these problems can be completely eliminated. Rather, the concern is with bringing them into manageable proportions.

The expanding community

Traditionally the small community has been regarded as the locus for activity to better the economic and social well-being of its citizens. The initiative of private citizens has of course been the keystone. With increasing specialization, industrialization, and urbanization, the concept of community self-sufficiency has become less viable, although individual involvement remains an important principle.

Agriculture, business, industry, and government have become increasingly interrelated in the process of economic growth. With specialization and the efficiencies this allows, we become more dependent upon one another for goods and services. Economic and social forces and policy decisions far outside our communities affect our jobs, our families, and our institutions.

The geographic base for development has therefore grown to encompass a county, a multi-county area, or often an economic area cutting across state lines. Of Illinois's 102 counties, 53 have established planning programs, either independently or in cooperation with other counties (ILLINOIS RESEARCH, Winter, 1967). There are 10 multi-county or regional planning units in the state. These are evidence that Illinois citizens are recognizing the importance of dealing with certain planning and development problems on a realistic scale. Planning, of course, is intrinsically neither good nor bad, but is rather what citizens make of it.

Community resources

Regardless of size, every community has three basic kinds of resources. These are the *physical resources* — capital, land, water, and other natural resources; *human resources* — people and their attitudes, education, skills, and talents; and *institutional resources* — schools, churches, markets, government groups, and other organizations and services.

Deficiencies, misuse, or underdevelopment of any of these community resources result in inefficiences and imbalances in an area's development. Human resources are the ones most likely to be underrated.

Public affairs education

Most community or area problems must be solved through policies decided upon and supported by the citizens. Issues involving public health, welfare, education, employment, land and water use, recreation, and flood control, for example, usually call for some kind of group or community action.

To bring about desired changes, citizens must become aware of the situation, appraise the possible alternatives and the consequences of each, and take action. Since this is a continuing process, there is a place for a broad public affairs education program for responsible citizenship. As most problems have several aspects, it is the goal of such a program to help people study the problems they face and to examine the probable economic and social consequences of alternative lines of action.

Technical competence needed

Educational programs for creating awareness and understanding of changes and for developing an organizational structure to effect changes are not enough. Technical competence must be available for both planning and implementation.

While the task of providing technical assistance does not rest solely upon the University, the implications for education are clear. Research and training should be directed toward developing the capabilities of college graduates who will work for public or private agencies concerned with community improvement. Furthermore, the technical services of extension specialists from the University should be made available to requesting communities.

Extension project VII

A group of Cooperative Extension Service specialists are now working together in what is known as Project VII, which is concerned with community and area resource development and public affairs. The specialists' areas of technical competence differ, but their objective is the same — to help Illinois people understand and cope with some of the problems associated with economic growth.

These problems may be in community organization, county or regional planning, public health, rural recreation, local government and taxation, or agricultural policy. Some of the problems will be discussed in more detail in future issues of ILLINOIS RESEARCH.

H. J. Schweitzer is Associate Professor of Rural Sociology Extension; L. P. Fettig, Assistant Professor of Agricultural Economics.

Build Soil Fertility With Soybeans!

D. L. MULVANEY and J. W. PENDLETON

Do you ever wonder what to do with those idle or government acres? On too many farms they are simply an eye sore and weed patch. How about a soybean green manure crop?

A recent experiment at the Northern Illinois Agronomy Research Center near DeKalb indicates that soybeans plowed under as green manure can put more corn in the bin next year than about any other crop.

The table at right shows what crops were grown in 1965. All plots were fall-plowed. In the spring of 1966 we divided each plot into thirds to compare two different nitrogen treatments (50 and 100 pounds per acre) with no treatment. Then we planted corn.

The 1966 growing season was not particularly good, and the corn yield didn't exactly burst the bin. However, as shown in the table, plowing under soybeans greatly increased the yield of corn. Surprisingly, the poorest yields were on plots where high populations of corn had been plowed under the previous fall. We say "surprisingly" because more dry matter was plowed under on these plots than on any of the others.

We did not analyze the crops for their carbon and nitrogen content. However, the soybeans when plowed under must have provided much more nitrogen in relation to carbon than any other crop or treatment.

Harvested for seed, soybeans have been the mortgage lifter on many Midwestern farms. Farmers sometimes forget, however, that soybeans are also the best green manure crop we have. We are not advocating a wholesale shift to a green manure system of farming, but we do wonder if many farmers aren't overlooking soybeans for those "idle acres."

D. L. Mulvaney, Assistant in Soil Fertility, is stationed at the Northern Illinois Agronomy Research Center; J. W. Pendleton is Professor of Agronomy at Urbana.

Effect of Previous Crop on Corn Yields, DeKalb, 1966

Previous crop (1965)	Nitrogen applied, lb./acre			Aver.
	0	50	100	
	Corn yields, bu./acre			
Oats (clover catch crop)	84.3	97.3	101.8	94.5
Soybeans drilled and plowed under	108.2	112.8	115.6	112.2
Soybeans 40" rows and plowed under	103.2	114.0	116.5	111.2
Regular soybeans harvested for grain	80.8	94.6	102.3	92.5
Corn drilled and plowed under	57.1	79.0	89.5	75.2
Regular corn harvested for grain	72.2	94.6	99.9	88.9
Average	84.3	98.7	104.7	95.8

Mode of Inheritance of Crimson Fruit Color in Tomatoes Is Established by Cooperative Research

A. E. THOMPSON

Crimson tomato fruits, a new red color type, reach a commercially acceptable color 3 to 5 days earlier than normal-red tomatoes. Rapid color development in relation to the other ripening processes in tomato fruits is quite important economically, especially in mechanical harvesting.

Cooperative research by the Illinois and Purdue Agricultural Experiment Stations has characterized the carotenoid pigments, and identified the mode of inheritance of crimson. Crimson fruit color results from an increase in the red pigment, lycopene, concurrent with a reduction in the yellow pigment, beta-carotene. The modification of the lycopene-carotene (red-yellow) ratio is most pronounced in the area around the seeds of the tomato fruit.

Genetic data indicate that the crimson character is conditioned by a single recessive factor, which is allelic with the gene for old gold flower color (og), and closely linked with genes for self-pruning (sp) and high beta-carotene (B) on chromosome 6. It is thought that the crimson and old gold factors are not identical even though they are located at the same locus on the chromosome. Therefore the symbol og^c has been proposed to designate the crimson factor as typified by that found in the variety High Crimson. This symbol replaces the two symbols Crn_1 and crn_2 previously proposed by other research workers.

The mode of action of og^c in certain genetic backgrounds indicates incomplete dominance of the normal allele. The amounts of both lycopene and beta-carotene in the heterozygote ($+/og^c$) have been found to be intermediate between those in crimson (og^c/og^c) and those in normal red ($+/+$) tomato fruits.

Crimson is often difficult to classify within segregating populations since its appearance may be modified by the interaction of environment and additional modifier genes in parental varieties. Preliminary classification of plants with crimson fruits can be made by selecting plants with gold-colored flowers. Plants that will breed true for crimson can be separated from those that will segregate in succeeding generations, since those with intermediate crimson color ($+/og^c$) will not have gold-colored flowers.

A. E. Thompson is Professor of Plant Genetics, Department of Horticulture.

FARM BUSINESS TRENDS

Hog production has been the most important and profitable livestock enterprise in Illinois for many years. It is also a growing industry in the state — or at least it was until three years ago.

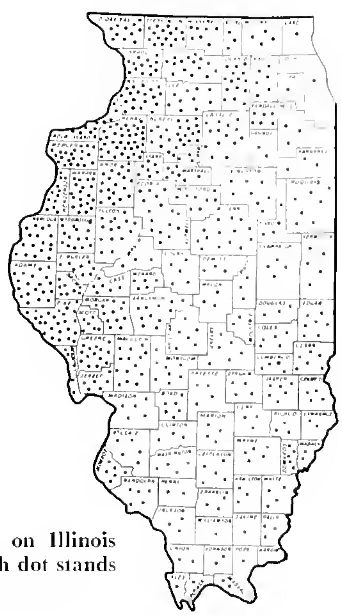
According to the latest official figures, sales of hogs brought Illinois farmers $548 million in 1965. That was 22.3 percent of all cash received from the sale of farm products. Corn was the biggest cash producer, with 24 percent of the total. Cattle and calves ranked third, with 19.6 percent; and soybeans fourth, with 16.7 percent.

First pig crop reports were made in 1924, when Illinois farmers saved an estimated 6.8 million pigs. The pig crop was cut to 5 million after the great drouth of 1934. During World War II, surplus corn and wheat were used to expand production, and Illinois farmers saved 11 million pigs in 1943. This record was exceeded in 1955, and further increases carried the Illinois pig crop to an all-time high of 13.1 million in 1963. Illinois farmers cut production in 1964 and 1965, but began to expand in 1966. The 1966 Illinois pig crop was estimated at 11.2 million, and the 1967 crop is expected to be about 11.5 million.

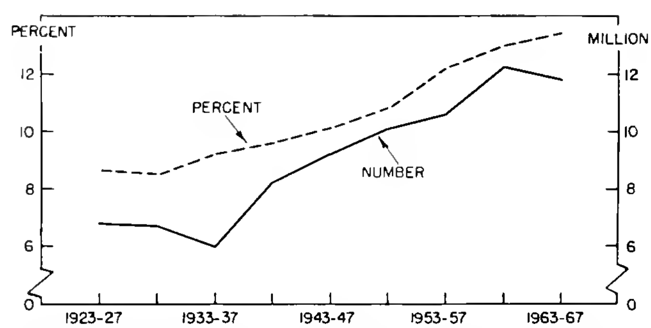
A hundred years ago, when the first estimates of livestock on farms January 1 were made, Illinois farmers had 11 percent of all hogs in the country. When the first pig crop report was made in 1924, the Illinois share was 9.1 percent. Our share shrank to 8.2 percent by 1929. Then Illinois farmers began to take over more of the market. By 1964 they produced 13.9 percent of the nation's pigs. Their share shrank to 13.6 percent in 1965 and to 13.1 percent last year. This may be a temporary decrease, such as has occurred a few times previously.

In the past, most of our hogs were produced as a sideline on farms where corn production was the leading enterprise. Future hog production seems likely to be concentrated in a relatively few large-scale specialized operations resembling factories.

Freight rates and weather conditions will largely direct the location of hog production in future years. As costs of shipping corn decrease, costs of production tend to equalize throughout the Corn Belt. Illinois, with a large and increasing amount of cash corn, should remain in a very strong competitive position in the hog industry. — *L. H. Simerl*



Number of hogs on Illinois farms, 1964. Each dot stands for 10,000 head.



Pigs produced in Illinois: Number and percent of U.S. total, five-year averages, 1923-1967.

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

In this mechanized feed center for dairy cattle, the complete ration is automatically fed in the feed bunk (page 8).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell.......................Director

Margery E. Suhre ....Editor, ILLINOIS RESEARCH

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NEWS AND VIEWS

Managing Plant Processes

WE LIVE in an era of accelerated change that permeates the whole fabric of modern society. New science-based technology continues to shrink the barriers of time and space that for ages have sheltered individuals, communities, and nations from the problems and aspirations of their contemporaries in other parts of the world. The removal of these barriers has helped to increase our awareness of the tremendous food production problem inherent in the rapidly expanding world population.

Food production depends on the basic natural resources of land, water, sunlight, and air. It is made possible through the alchemy performed by the chlorophyll of the green leaf as it captures energy and stores it in the form of organic compounds. These compounds then undergo the series of elaborate biochemical syntheses and transformations that constitute plant growth. Much of our progress in agriculture has come from our ability to stimulate, modify, or otherwise alter the way in which this remarkable "biochemical factory" — the green plant — functions.

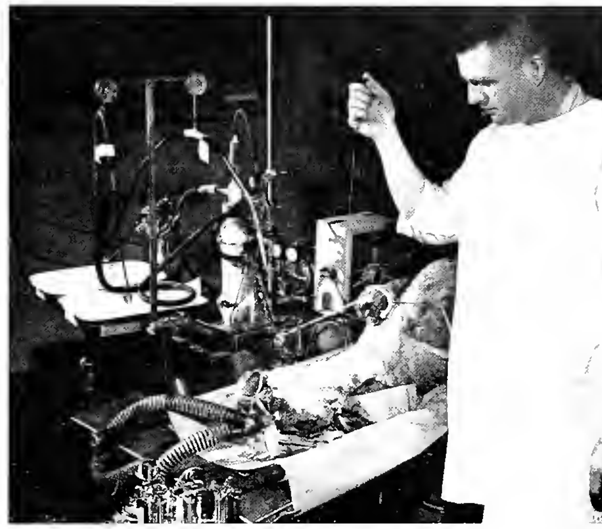
As we learn more about the complex processes that occur in living plants, we become aware of new ways to influence them and thereby to alter the nature and composition of the plant itself. Thus detailed study of the way nutrient ions move through membranes yields suggestions for increasing the efficiency of fertilizer use by crops. Knowledge of the enzymatic regulation of nitrogen metabolism in corn and wheat helps us to understand how these important crops respond to differences in light, temperature, and the nitrogen supply in the root zone. Studies of the mechanism which disperses solar energy through the leaf canopy in a corn or soybean field have led to suggestions for changing planting patterns and plant type to increase the efficiency of energy capture.

These are but a few examples to show how increased knowledge of that wonderfully complex set of processes involved in plant growth can provide new opportunities for the intelligent management of plants, which constitute the key component of the great biological system known as the food chain. In view of the continually expanding world need for food, agricultural scientists face a clear and imperative challenge in their efforts to increase our skill in managing plant and animal growth processes. — *M. B. Russell*

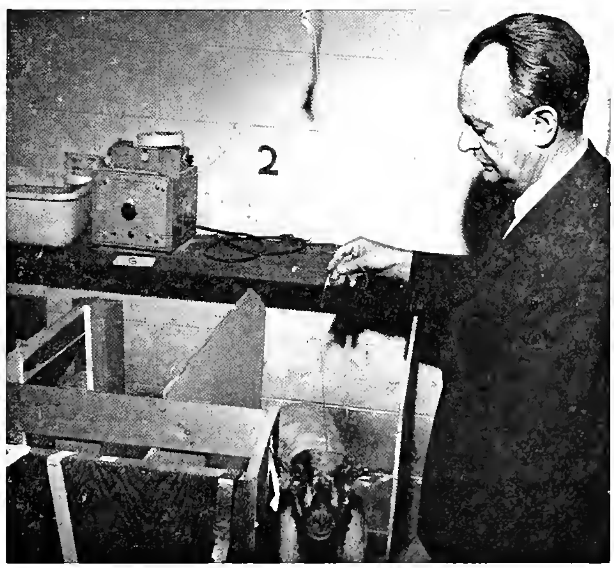
OF GLANDS AND HORMONES

A major breakthrough in the genetic improvement of animals may result from research in basic endocrinology

A. V. NALBANDOV



To study the effect of a hormone, it is first necessary to remove the source of that particular hormone. Here C. C. Kaltenbach is getting ready to remove the pituitary gland, the source of many important hormones, from an anesthetized ewe.



A. V. Nalbandov, Professor of Animal Physiology, Physiology, and Zoology, observes the effects of injecting hormone into a sheep whose pituitary gland has been removed. Removal of the gland creates a hormonal vacuum, making it possible to replace one hormone at a time. A plastic tube in the sheep's jugular vein is connected through a continuous perfusion pump (shown on shelf) to a bottle of hormone which is kept cold in the plastic vat next to the pump. The hormone being studied is infused continuously for 10 to 20 days.

Some 40 years ago, when physiologists became seriously interested in studying the hormones produced by glands of internal secretion, great things were expected of this new science. The reason for this excitement was that some hormones were shown to control rate of body growth, while other hormones, it turned out, governed reproduction and lactation.

Those of us who were working with hormones had visions of being able to cause more rapid growth or more efficient reproduction by supplying the appropriate hormones to our domestic animals. Soon, however, our vision turned to ashes, for we learned that the animal body is an exquisitely tuned machine which cannot be modified to any significant extent without upsetting the fine adjustments which are required for proper function. Thus, practical application of this new science had to be postponed until we could learn enough about the animal body, its functions, and its adjustments to see how much we dared interfere with its normal settings and calibrations.

The expenditure of time and money on the study of basic endocrinology, as the science of hormones is called, is beginning to pay off, and again we are hopeful that the time of practical application is very near. Thus, for instance, the control of the reproductive cycle of most domestic animals is now within our grasp. It appears possible that we may concentrate calving, lambing, and farrowing periods to those weeks or months which are most convenient to the farmer from the point of view of financial profit, weather, availability of space, labor, or other considerations.

Early difficulties

One of the difficulties encountered by scientists lies in the fact that hormones are unstable and elusive substances. They are produced in small quantities and disappear quickly from the bloodstream which bathes those organs that know how to respond to hormonal stimuli. Yet it is vitally important for us to know how much of each hormone under study is being produced at all crucial stages of growth or reproduction.

In the infancy of our science, when we wanted to estimate the rate of hormone production, the only thing we could do was to kill large numbers of animals and analyze their glands for hormone content. Information obtained from such experiments was very important because it taught us about the basic physiological mechanisms and laws governing growth and reproduction. Unfortunately, since the animals had to

be killed before we could obtain this information, they could no longer be used for seed stock.

We learned, for example, that the pituitary glands from a strain of fast-growing pigs contained significantly more growth hormone than did the glands from a slowly growing strain, but this information became available only after the rapidly growing animals were dead and thus no longer useful as sires or dams of future generations.

New assay methods

As time went on we realized more and more that, unless we could study the hormones of animals on the hoof, our aim of making them grow faster or be more prolific could not be realized. Within the last few years there appeared increasingly stronger evidence that the end of our frustrations was in sight. Jointly the chemists, physicists, and physiologists developed new techniques which made it possible to detect, through chemical analysis, small quantities of certain types of hormones in the blood of living animals.

These techniques are highly sophisticated, requiring the use of radioisotopes and extremely complicated and expensive electronic gadgetry. Their main advantage is that we can take a blood sample whenever we wish and, after appropriate preparation and extraction of the sample, can determine how much of this or that hormone is being secreted on any given day of the reproductive cycle or of pregnancy. These methods are applicable to the so-called steroid hormones, produced by the ovaries, testes, and adrenals.

The pituitary hormones, which stimulate body growth, and the gonads, which are concerned with reproduction, are protein in nature and at present cannot be estimated by chemical means. However, here too a major breakthrough has occurred, making it possible to estimate the concentration of these hormones in the blood by immunological means.

These assay methods are complicated and time-consuming, but they have the great advantage over all other methods in that they permit us to estimate hormone levels in very small quantities of blood. This, in turn, permits taking as many samples as are needed.

Practical applications

What can we do with all these refined assay methods? Most exciting to me appears the possibility of a real breakthrough in the genetic improvement of domestic animals.

In the past it has been impossible to predict with accuracy how fast or efficiently an animal will grow or how much milk it will give when it matures. The new assays are making it possible, for instance, to obtain blood samples from beef calves or from growing swine and to determine the growth hormone concentration in them. From data now available, it appears highly probable that the animals with the highest concentration of growth hormone will also be the ones who will grow the fastest. Since growth rate is an inherited characteristic, it is likely that such assays will some day form the basis for selecting sires and dams for the production of future generations of meat animals.

This approach will certainly be a vast improvement over the techniques which are now available to animal breeders and which are now used for the selection of breeding stock. It is equally probable that these new methods of hormone determination will allow us to distinguish the less prolific litter-bearing female from the more prolific and the potential high milk producer from the low producer.

Interest in the physiology of reproduction and growth is increasing in some progressive, forward-looking colleges of agriculture. The realization is growing that modern physiology promises more rapid advances in the control of growth rate and of reproduction of domestic animals than do the traditional approaches which at present dominate many departments of animal science. Much work remains to be done, however, before practical application of the new techniques becomes a reality in everyday animal production.

Other possibilities

In this brief survey I have directed attention to those problems of applied physiology which have been solved or appear to be on the edge of solution and practical application. There remains a vast area of endocrine physiology which is so new that we still don't know whether it will remain an intellectual curiosity or whether it too will help to improve animal production.

I am talking of the hormones called "releasing factors," which originate in certain portions of the brain or central nervous system and which play an important role in the control of behavior, growth, and reproduction. These releasing factors are chemically far simpler than are the protein hormones secreted by the pituitary gland. There is therefore greater hope that they can be synthesized and thus made available cheaply and in large quantities. Those of us who work with releasing factors feel that, if and when they become available in quantity, which may be in the not too distant future, they will give us even more powerful tools of controlling growth and reproduction than those now available.

In short, the future of physiology as applied to practical and theoretical problems of animal production looks indeed bright and promising. The great increase in the number of mouths to be fed throughout the world demands more and more ingenuity in finding new and more efficient ways of producing food. Scientists engaged in the study of modern animal physiology are very hopeful that they will provide some of the important means of improving efficiency of growth and reproduction in our domestic animals.

As in all aspects of modern science, the solutions to the problems discussed require modern methods, up-to-date equipment, and much money. Above all, we need progressive thinking and the recognition that some of the means of solving agricultural problems which were fruitful in the past, no longer pay off and should be curtailed or eliminated.

SLOPE OF THE ILLINOIS LANDSCAPE

E. C. A. RUNGE, S. G. CARMER, and L. E. TYLER

As anybody familiar with Illinois knows, the east-central and northeastern parts of the state are nearly level, while the southern and northwestern parts include more rolling and hilly topography. Obviously, however, such qualitative terms as "nearly level" or "hilly" are not precise. A "hilly landscape," for example, may mean one thing to a resident of Douglas County and something quite different to someone who lives in Jo Daviess County.

For greater accuracy, soil scientists in recent years have been describing topography in terms of percent slope. This gives the vertical change in feet for each 100 feet of horizontal distance. A 20-percent slope, for example, means 20 feet of vertical change in 100 feet of distance.

A sample survey

Percent slope has not yet been determined in detail for all the soils in every county, but we do have the results of a recent sample survey by the Soil Conservation Service in cooperation with the Department of Agronomy, University of Illinois. This survey was made for the National Conservation Needs Inventory (CNI) as part of a nationwide study of physical land conditions.

Nearly 700,000 acres in Illinois, or 2 percent of the land area, were mapped. The mapped areas consisted of about 4,500 quarter-sections selected at random. Generally three quarter-sections were mapped in each legal township (36 square miles).

Information collected for the CNI study includes soil type, slope, degree of erosion, and land use, by acres, for the year the sample was mapped. The location of each sample (county, watershed, and soil association area) was also recorded. Mapping was completed in 1962. The collected information was then coded and transferred to IBM cards.

Information selected and analyzed

The present analysis is based on the information about slope and sample location. The percent slope in each sample was coded alphabetically. The letter symbols, the range in slope that each includes, and the percent slope chosen to represent the range are as follows:

Letter symbol	*Percent slope*	
	Range	*Representative*
A	0– 1.5	1.0
B.	1.5– 4.0	2.5
C.	4.0– 7.0	5.5
D	7.0–12.0	9.5
E.	12.0–18.0	15.0
F.	18.0–30.0	24.0
G.	30.0 plus	35.0

After coding all the slope units that had been mapped, we multiplied the number of acres in each slope range by the percent slope representing that range. To determine the average slope of a county, we added the products obtained by multiplying percent slope and acres; then divided by the number of acres mapped. The same procedure was followed in determining average slope of major watersheds and soil association areas.

Average slopes by county

Average slopes obtained for the counties are given in Figure 1 and Table 1.

People responsible for education and action programs in the counties need to recognize the relative advantages and limitations due to slope. Douglas County, for example, has the lowest average slope (1.68 percent) and Calhoun County the highest (17.63 percent). Douglas County is primarily a cash-grain area where inadequate drainage may limit production. In Calhoun County emphasis is on orcharding because erosion limits the production of row crops.

Slopes of watersheds

In Figure 2 and Table 2 we see the slopes of the major watersheds — or those with an area of 750 square miles or more. The Illinois, Ohio, and Mississippi watersheds as used here include only the small watersheds (less than 750 square miles) draining into these rivers.

There is some shift in interpretation when average slopes are presented by watershed rather than by county. The general pattern, however, remains the same. The Iroquois River watershed has the lowest average slope (1.75 percent) and the Ohio River watershed the highest (10.11 percent).

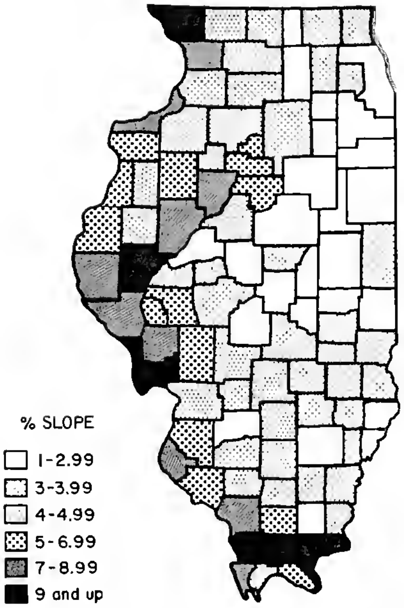
Slopes of soil association areas

Slope information is given by soil association area in Figure 3. (Incidentally, soil associations are designated on the map by letters which have no relationship to the letters designating slope range.)

When slope information is presented by soil association area, the average slope picture for Illinois is quite different than when the information is presented by county or by watershed. For example, Figure 3 shows large areas of nearly level land throughout most of Illinois and not just in the east-central and northeastern counties.

With three exceptions, the dark-colored, prairie-derived soil association areas have average slopes below 2.5 percent. The three exceptions (associations A, G, and H) have slopes between 3 and 3.5 percent. The relatively high average slope for association A (Joy-Tama-Muscatine-Ipava-Sable) is due in part to the large number of streams dissecting this association. Timbered soils be-

E. C. A. Runge is Assistant Professor of Pedology and S. G. Carmer, Associate Professor of Biometry, both in the Department of Agronomy. L. E. Tyler is State Soil Scientist, Soil Conservation Service.



Average slope by county. Table 1 gives specific figures for each county. (Fig. 1)

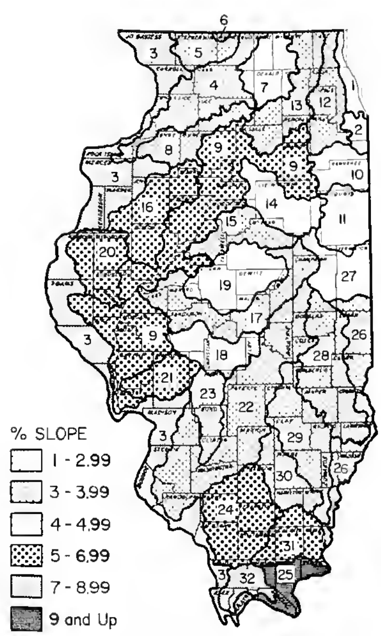
Table 1. — Average Slope for Each County in Illinois

County	Pct. slope	County	Pct. slope	County	Pct. slope
Adams	7.43	Hordin	14.68	Morgan	6.25
Alexander	7.00	Henderson	6.97	Moultrie	2.05
Bond	3.46	Henry	4.21	Ogle	4.29
Boone	2.63	Iroquois	1.72	Peoria	8.33
Brown	10.60	Jackson	7.95	Perry	4.09
Bureou	4.54	Jasper	3.58	Piatt	2.11
Calhoun	17.63	Jefferson	4.87	Pike	8.70
Corroll	7.34	Jersey	10.12	Pope	10.45
Coss	4.99	Jo Daviess	10.25	Pulaski	4.87
Chompoign	1.93	Johnson	12.11	Putnom	6.22
Christion	2.39	Kane	3.09	Randolph	6.33
Clark	3.88	Konkakee	1.81	Richland	3.07
Cloy	3.11	Kendall	2.19	Rock Island	7.09
Clinton	2.30	Knox	6.30	St. Clair	5.04
Coles	4.77	Lake	3.29	Soline	2.90
Cook	2.91	LaSalle	3.58	Songamon	3.17
Crowford	3.53	Lawrence	2.70	Schuyler	9.77
Cumberland	3.23	Lee	3.10	Scott	6.20
DeKalb	2.19	Livingston	1.96	Shelby	3.75
De Witt	3.34	Logan	2.34	Stork	4.49
Douglas	1.68	McDonough	3.87	Stephenson	4.41
DuPage	3.17	McHenry	3.25	Tazewell	4.43
Edgar	2.51	McLean	2.48	Union	9.70
Edwords	3.76	Macon	2.46	Vermilion	3.19
Effingham	3.71	Macoupin	6.11	Wobash	2.71
Fayette	4.12	Madison	4.96	Worren	4.05
Ford	1.88	Morion	4.62	Woshington	3.24
Franklin	3.34	Marshall	6.70	Wayne	2.71
Fulton	7.65	Mason	2.91	White	4.16
Gollatin	3.38	Mossac	6.13	Whiteside	3.41
Greene	8.15	Menard	4.90	Will	2.90
Grundy	1.70	Mercer	5.15	Willliamson	6.07
Homilton	3.72	Monroe	8.87	Winnebago	3.58
Honcock	6.10	Montgomery	4.95	Woodford	5.35

longing to the Seaton-Fayette-Stronghurst association occur along many of these streams and are included with association A on the small-scale map in Figure 3.

Some of the flattest land in Illinois occurs in association F (Hoyleton-Cisne-Huey). In our calculations, however, the average slope for this association is 0.1 percent greater than for association B (Sidell-Catlin-Flanagan-Drummer). The reason is that association F is dissected by more minor streams so that more small areas of sloping timbered soil are included within the association. The sloping soils included in association F belong to the Ava-Bluford-Wynoose association; those in association B belong to the Birkbeck-Ward-Russell association.

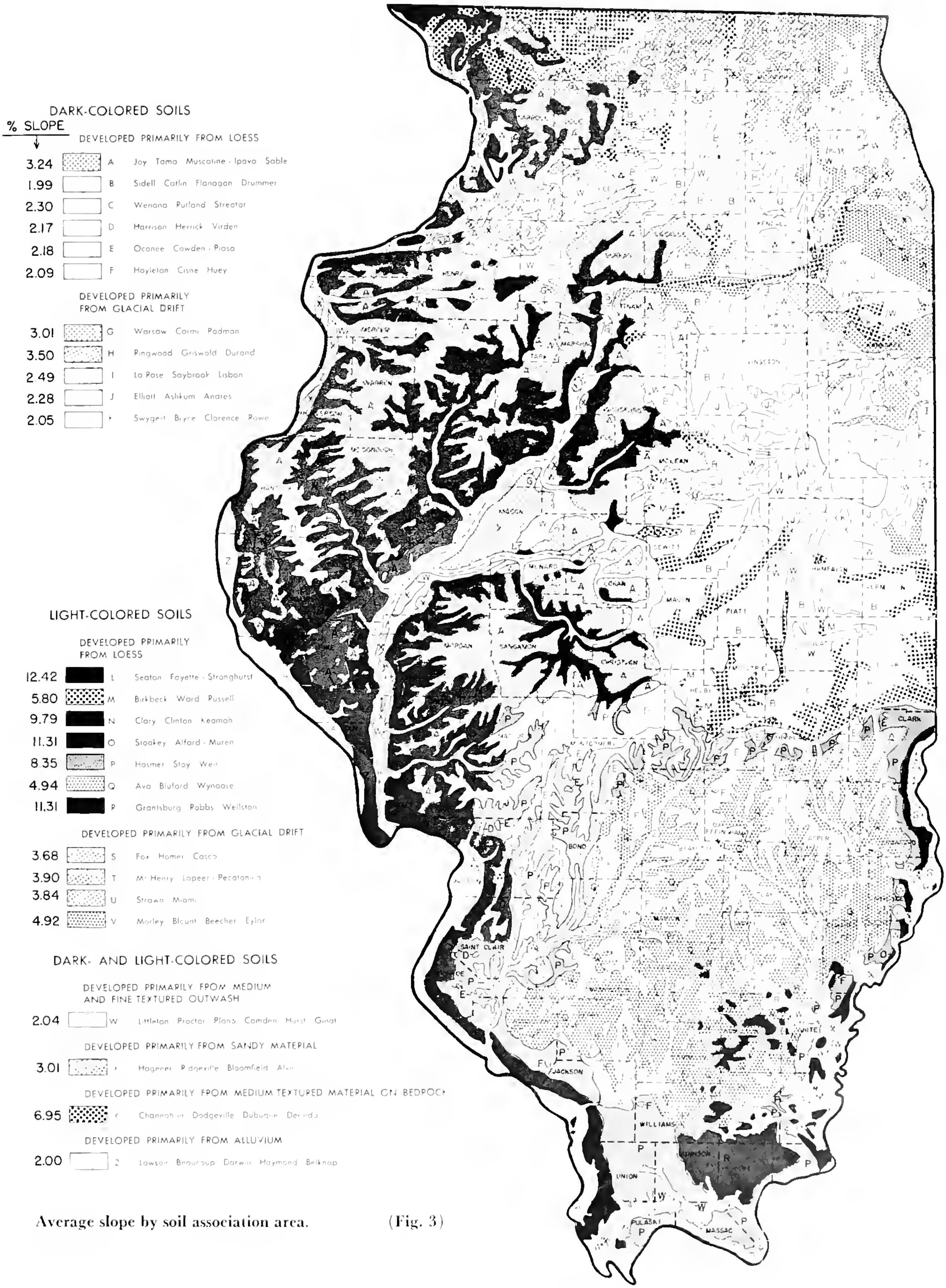
Slope estimates by county are more useful if supplemented by information about soil association areas. Hancock County, for example, has an average slope of 6.10 percent. On the soil association map, however, it has five main slope areas; association Z, with a slope of 2.00 percent; D, 2.17 percent; A, 3.24 percent; N, 9.79 percent; and L, 12.42 percent. Similar slope breakdowns by soil assocation can be made for most counties. Specific slope information is included in the latest county soil reports.



Average slope by major watershed. See Table 2 for watershed names. (Fig. 2)

Table 2. — Average Slope for Major Watersheds in Illinois

Watershed	Pct. slope
1. Loke Michigan	1.81
2. Calumet River	2.67
3. Mississippi River	7.92
4. Rock River	4.00
5. Pecotonica River	3.82
6. Sugar Creek	3.64
7. Kishwaukee River	2.51
8. Green River	3.23
9. Illinois River	6.61
10. Konkakee River	2.10
11. Iroquois River	1.75
12. Des Ploines River	3.24
13. Fox River	3.11
14. Vermilion River	2.12
15. Mackinaw River	3.34
16. Spoon River	5.29
17. Sangomon River	3.97
18. South Fork Sangomon River	2.19
19. Salt Creek	2.74
20. La Moine River	6.34
21. Macoupin Creek	5.92
22. Kaskaskia River	3.61
23. Shoal Creek	4.26
24. Big Muddy River	5.29
25. Ohio River	10.11
26. Wobosh River	3.34
27. Vermilion River	2.52
28. Embarass River	3.14
29. Little Wobosh River	3.14
30. Skillet Fork	3.94
31. Soline River	6.62
32. Cache River	7.49



Average slope by soil association area. (Fig. 3)

Automatic Bunk-Feeding of Dairy Cattle

E. F. OLVER, K. E. HARSHBARGER,
and H. B. PUCKETT

Group-feeding the complete ration in the feed bunk appears feasible when cattle are at the same level of production

THE MODERN COW will have to "go along with the crowd" as automatic equipment is introduced onto dairy farms. She will generally rate individual attention only for breeding, calving, or veterinary treatment.

With automation, cows have to be fed, milked, and housed in groups. Feed and milk have to be handled in bulk. Not only must labor be used efficiently, but a uniformly high production must be maintained as well. One man should handle enough high-producing cows to account for 500,000 to 700,000 pounds or more of milk a year.

Experimental mechanized center

A mechanized center (Figs. 1 and 2) has been set up on the University dairy farm to test the concepts of group handling and mechanical feeding of dairy cattle. Specifically, we are trying to determine the feasibility of automatically feeding a complete ration in the feed bunks. The feeding system is designed to handle 80 cows, 60 of them lactating. The lactating cows are divided among three lots, 20 cows to a lot, while the dry cows are handled in a fourth lot.

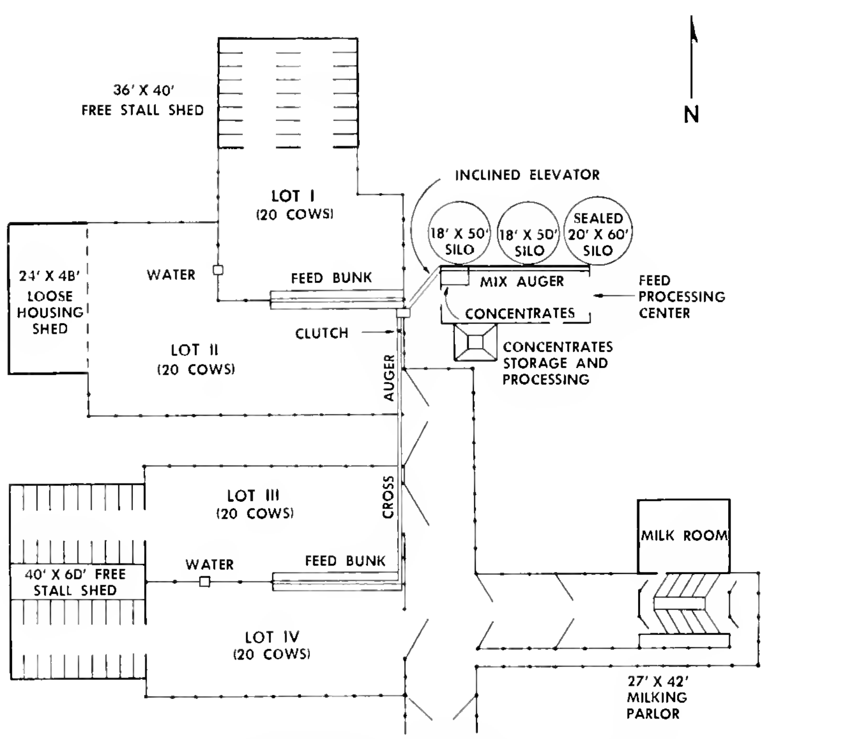
The control system (Fig. 3), which can be operated either manually or automatically, regulates the makeup and quantity of the ration for each lot. The various ingredients can be automatically removed from storage, mixed, and distributed to the lots.

Grass silage, "haylage," corn silage, and a concentrate mixture are the ingredients handled in this system. The concentrate mixture may be a premixed combination or it may consist of a maximum of four ingredients blended in an automatic hammer mill. After the concentrate mixture is blended, it is pneumatically conveyed to a holding tank equipped with a voltage-sensitive volumetric feed meter that regulates the proportion of concentrates to the silage. This feed meter is part of the main control system, although the hammer mill is operated independently of the system.

Silo unloaders, supported by cables, are in the top of the two west silos (Fig. 1). Each unloader consists of a gathering auger to bring the silage to the center of the silo and a blower-thrower to discharge it at a constant rate from the silo. A bottom unloader is used in the third silo, which is a sealed storage unit.

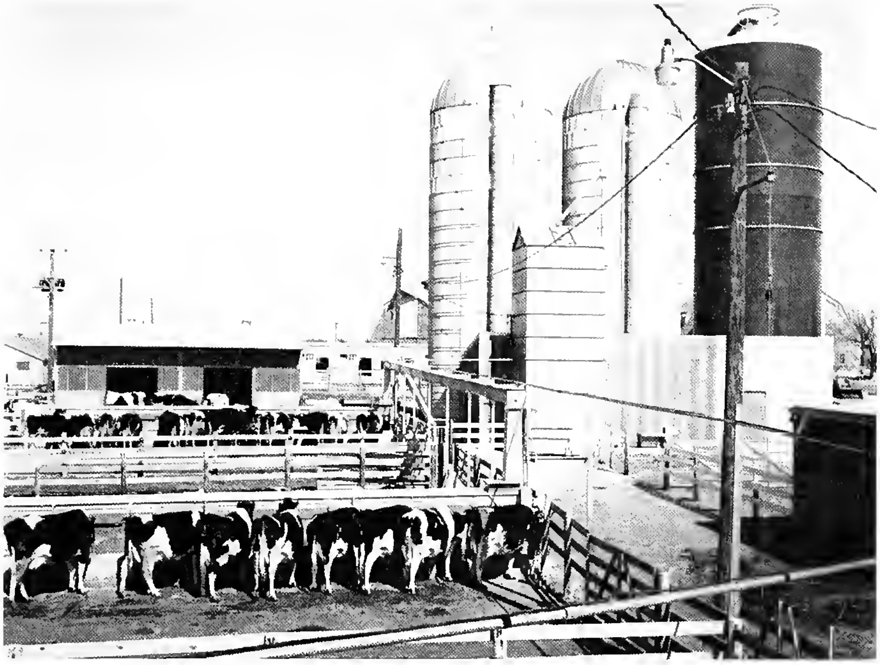
Since the combination and proportion of the several ingredients (corn and grass silage, "haylage," and concentrates) are under full control of the operator, the finished ration may consist of any one or any combination of the four major ingredients.

The rations are collected from the four sources by means of a common 9-inch auger. The auger serves as both a mixer and a conveyor, discharging the feed into an inclined chain flight elevator. The elevator in turn lifts the feed to a 90-foot cross-



Layout of the dairy cattle mechanization center. Four groups of 20 cows each can receive predetermined rations at separate feed bunks. Silage from the vertical silos drops at a constant rate into the mixing auger. Concentrates are prepared in the storage and processing unit, and are moved pneumatically to the concentrates tank. A feed meter under the tank drops the needed concentrates onto the silage in the mixing auger; the ration then flows to the inclined auger, to the cross auger, and to the appropriate feed bunk. (Fig. 1)

E. F. Olver is Professor of Agricultural Engineering; K. E. Harshbarger, Professor of Nutrition, Dairy Science Department; H. B. Puckett, Investigation Leader, Farm Electrification Research Branch, USDA.



Photograph of the center sketched in Figure 1. Lot IV is shown in foreground. The feed bunk for Lots I and II is at the other end of the 90-foot cross auger. The free-stall loafing shelter for Lot I is in the background at left. Entrance to the milking parlor is at the lower right of photograph. (Fig. 2)

auger conveyor about 10 feet above the ground. A clutch between the first 10 feet and the rest of the auger permits flexibility in the operation of the long auger. If feed is to be delivered to the first bunk, the first 10-foot section of the auger turns (counter clockwise). If feed is required at the other bunk, the controls reverse the cross-auger motor and the whole 90-foot auger turns (clockwise), conveying feed to the second bunk.

What the control system does

The control system can operate all of the silo unloaders (one, two, or three at a time), as well as the concentrate feed meter. The silage unloaders are set at a uniform delivery rate. To control the amount of a particular silage in a particular ration, the control system can vary the length of time that an unloader operates. The concentrate feed meter is adjustable so that different amounts of concentrate will flow from the storage tank to blend with the constant flow of silage.

Besides selecting and controlling the proportion of ingredients, the control system operates the conveying equipment that draws feed materials from the sources, mixes them, and discharges them at the desired location. The control system also energizes the equipment that dumps the feed to either side of the feed bunk.

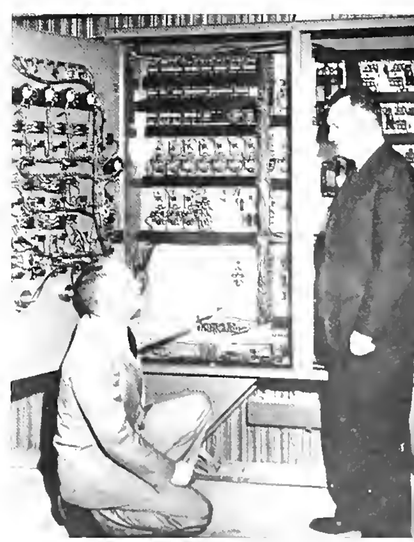
The feed delivery system is operated by a 24-hour time clock. Feed can be delivered as often as every 2 hours or as infrequently as once a day. Delivery to any one lot can continue for any length of time up to 30 minutes. After one delivery, the conveying equipment has to operate long enough to completely empty the system before a new batch of feed can be delivered to a second lot.

Several safety features are built into the control system to prevent delivery of a ration that is not properly mixed or constituted. One kind of device keeps the top silo unloaders from being too high or too low in relation to the silage. Another device shuts off the system and energizes a warning circuit if silage or concentrates are not being delivered. The system is also shut off if the conveyor motors are overloaded.

Effects on cows

In the first experiment with this system, lactating dairy cows utilized a bunk-fed complete ration of corn silage and concentrates as efficiently as an individually fed ration. Results indicated, however, that group feeding should be supplemented with individual feeding when the cows in a group vary widely in production. To meet individual feed requirements of cows at different production levels, it is better to feed part of the concentrate ration in the feed bunk and part in the milking parlor, rather than to feed all the ration in the bunk. This method may also reduce waste in feeding the lower-producing cows. However, concentrates do not have to be fed in the milking parlor to stimulate milk production or milk letdown.

Although group-feeding the complete ration in the feed bunk appears feasible, other experiments should be conducted, using lactating cows with much higher levels of production. The effects of grossly overfeeding low-producing cows and underfeeding high-producing cows in group feedings should be determined. A method of determining individual feed consumption under group feeding conditions is needed to provide a sound basis for evaluating the potential of the group feeding system.



Professors Olver and Harshbarger discuss the control panel, which is the heart of the automatic feeding system. (Fig. 3)

Chilled-Air Drying and Storage of Corn

GENE C. SHOVE

FARMERS who combine high-moisture shelled corn are faced with the difficult problem of drying large amounts of wet grain before microflora growth causes deterioration.

The time available for drying depends on the temperature and moisture content of the grain. Wet corn harvested and stored at 70° F. must be dried in a few days (Fig. 1).

Cooling the grain right after harvest will retard the growth of molds and fungi. For example, shelled corn harvested with a moisture content of 26 percent can be stored for one month if it is chilled and held at a temperature of 40° F. (Fig. 1). Chilling the grain to 35° F. would prolong the allowable storage time to about 45 days. During the allowable storage period the moisture content of the corn can be reduced by a process called dehydrofrigidation — the removal of moisture from a product kept at a low temperature.

Initial cooling

If dehydrofrigidation is to be used with shelled corn, the corn should be cooled within 24 hours after harvest if possible.

One pound of chilled air is needed to cool each pound of shelled corn from harvest temperatures of 60°-80° F. to temperatures between 30° and 40° F. The specific volume of a pound of chilled air is about 12.5 cubic feet. Dividing 12.5 by 1,440 minutes, we find that an air-flow rate of 0.00868 c.f.m (cubic feet per minute) is needed to chill a pound of corn in 24 hours. This amounts to about 0.5 c.f.m. per bushel, since a bushel of wet corn weighs about 60 pounds.

Moisture content of the corn may be reduced by about 0.5 percent during 24 hours of cooling.

Although night temperatures during corn harvest are often several degrees lower than day temperatures, night air cannot be depended upon for cooling grain. Mechanical equipment must be available for cooling the corn to the desired temperature.

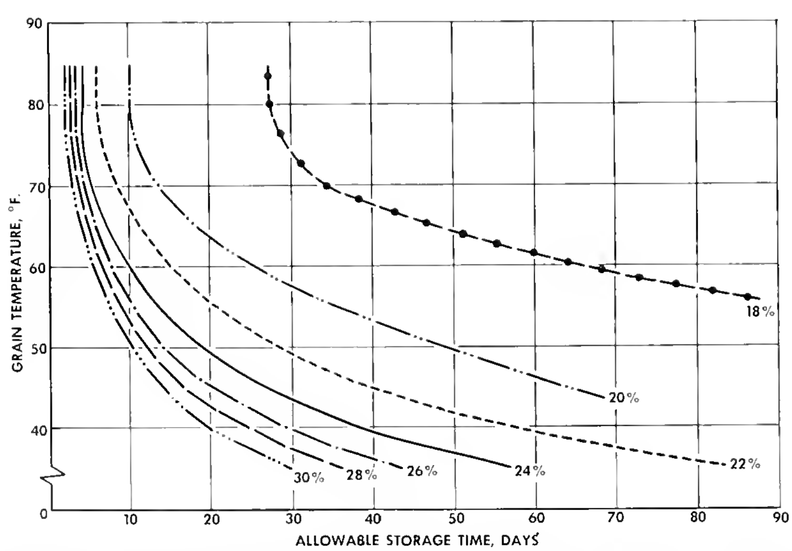
Since high temperature and humidity increase the load on air-conditioning equipment, both relative humidity and air temperature should be considered when matching equipment with the amount of grain to be cooled. The chilling rates in Table 1 can be used as a guide in selecting equipment with the proper capacity.

Thermostatic control is desirable to maintain the proper air flow during daily fluctuations in temperature and humidity. As outside air temperature and humidity increase, the air-flow rate must be reduced to maintain a given chilled-air temperature. Conversely, as air temperature and humidity decrease, air-flow rate can be increased. If properly controlled, grain chilling can continue around the clock with a minimum of supervision.

Chilled storage

Wet, chilled grain can be stored for several weeks without deterioration if a low grain temperature is maintained. Grain temperature will be increased by solar radiation and by heat conducted through the storage structure when air temperature is higher than grain temperature. However, insulation will reduce the heat gain from conduction and radiation.

Grain respiration and microflora activity generate heat in warm grain. Low temperature, however, inhibits these processes, so they will not be a major source of heat in grain that is kept cool.



Allowable storage times for shelled corn at various temperatures and moisture contents. During these times grain may lose 0.5 percent in dry matter. (Fig. 1)

Dehydrofrigidation — natural air

After the initial chilling, the grain can be dried by continued circulation of cool air. In much of the Corn Belt, natural air conditions can be expected to favor low-temperature drying for several weeks during the late fall and winter.

Drying grain with naturally cool air is a slow process. Comparing the amount of moisture that cool air can remove from wet grain (Table 2) with the amount that must be removed in drying (Table 3), we find that 1,000 c.f.m. of air will not dry much grain in a day. Consider a De-

Gene C. Shove is Associate Professor of Agricultural Engineering.

Table 1. — Approximate Daily Rates of Chilling Shelled Corn to 35° F. per Ton of Air Conditioning[a]

Av. daily air temp.	Av. daily relative humidity		
	30%	65%	100%
	bushels per day		
80° F.	300	200	100
70° F.	500	300	200
60° F.	800	500	300
50° F.	1,200	900	600

[a] A ton of air conditioning is 12,000 B.t.u. per hour.

cember day, for example, when average air temperature might be 30° F. and relative humidity, 70 percent. Each 1,000 c.f.m. of air would remove only 68 pounds of moisture. If corn with 24-percent moisture was being dried to 16 percent, 5.8 pounds of water would have to be removed from each bushel. Thus, only 11.7 bushels (68 ÷ 5.8) would be dried per 1,000 c.f.m. of air per day.

This could be a satisfactory drying rate if less than 1 kilowatt is required for each 1,000 c.f.m. of air. Power requirements can be kept within this limit if the grain depth does not exceed 30 feet with an air-flow rate of ½ c.f.m. per bushel, or 20 feet with 1 c.f.m. per bushel.

The final moisture content of corn dried with low-temperature air can be predicted by comparing average air conditions with equilibrium moisture-content data (Fig. 2).

Refrigerated air

In another method of low-temperature drying, a refrigeration system conditions the air to the desired temperature and relative humidity, and the air is continually recirculated. When moist air is exhausted from the wet grain, it is cooled at the evaporator coil, so that some water in the air will be condensed. The air is then heated to the desired temperature and relative humidity level by passing it over the condenser coil.

The relative humidity of the air can be controlled so that grain is dried to a given moisture level. For example, if corn is to be dried to 15- to 16-percent moisture with cool air, the relative humidity must be maintained near 70 percent (Fig. 2).

Table 2. — Amount of Water Removed Daily per 1,000 c.f.m. of Low-Temperature Air[a]

Av. daily air temp	Av. daily relative humidity				
	40%	50%	60%	70%	80%
	lb. water removed per day				
30° F.	139	114	92	68	46
40° F	191	162	126	97	58
50° F	245	202	152	120	82

[a] Moisture removal rates are based on saturated exhaust air. If air exhausts at less than 100 percent relative humidity, the rates must be reduced.

Table 4. — Approximate Daily Drying Rates per Ton of Air Conditioning[a]

Initial moisture content of corn	Air temperature		
	30° F.	40° F.	50° F.
	bushels per day		
26%	9	13	16
24%	12	17	21
22%	16	23	28
20%	16	23	28
18%	14	22	28

[a] Recirculated air maintained with relative humidity of 70 percent for drying corn to 15- to 16-percent moisture.

To cool the air exhausted from the grain and condense the water, about 2.2 B.t.u. must be removed per pound of air. The amount of air that can be handled by an air-conditioning capacity of 12,000 B.t.u. per hour is therefore 5,450 pounds per hour (12,000 ÷ 2.2). This is about 1,100 c.f.m. at 30° to 50° F. Although the daily drying rates would not be high (Table 4), the system can be designed to operate over the maximum allowable storage time so that requirements for air-conditioning equipment will be as low as possible.

Costs and energy use

Initial investment costs for insulated storage facilities with mechanical equipment will probably range from 70 cents to $1 per bushel.

Energy use and operating costs will vary with weather conditions. Outside air temperature in particular will affect the cost of chilling grain and of holding and conditioning it at low temperatures.

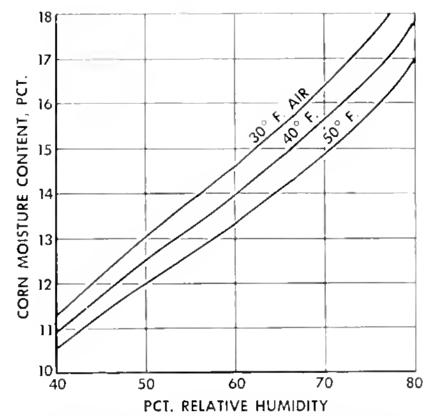
This variation makes it difficult to estimate energy use accurately, especially since relatively few data are as

Table 3. — Amount of Water That Must Be Removed to Produce 56 Pounds of Dried Corn

Initial moisture content	Final moisture content of corn				
	13%	14%	15½%	16%	17%
	lb. water to be removed				
28%	11.7	10.9	9.7	9.3	8.6
26%	9.8	9.1	8.0	7.5	6.8
24%	8.1	7.4	6.3	5.8	5.2
22%	6.5	5.7	4.7	4.3	3.6
20%	4.9	4.2	3.2	2.8	2.2

Table 5. — Potential Electrical Energy Use in Low-Temperature Grain Conditioning

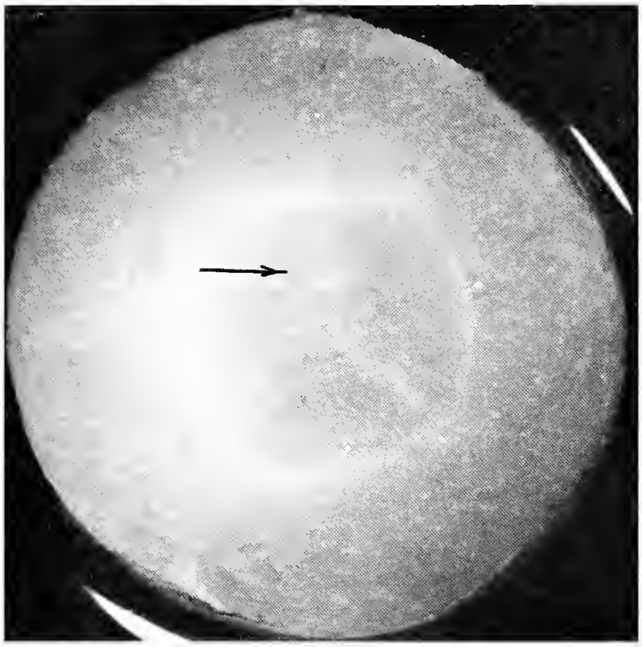
System or operation	Kw. hr. per bu.
Initial chilling	0.2 to 0.5
Chilled storage for 6 months to 1 year	1.0 to 3.0
Dehydrofrigidation	
Natural (ambient) air	0.6 to 3.0
Refrigerated air	2.0 to 5.0



Equilibrium moisture content of shelled corn dried with air at various temperatures and relative humidities. (Fig. 2)

yet available. The closest estimate that can be made on the basis of current research results and limited field data is that power requirements will range from 2 to 2.5 kilowatts per ton of refrigeration and about 1 kilowatt per 1,000 c.f.m. of air delivered. On the basis of these figures, potential energy use for conditioning a bushel of corn can be estimated (Table 5).

Local electrical energy rates can be applied to the values in Table 5 and a cost comparison made between low-temperature conditioning and drying with heated air.



A colony of the bacterium ***Pseudomonas chlororaphis*** growing on the xylem portion of a carrot slice. (Fig. 1)

Here colonies of an unknown bacterial contaminant are growing on beef steak. (Fig. 2)

BACTERIAL GROWTH ON SOLID SURFACES

Studies of conditions influencing the growth of bacteria will eventually help to cut the enormous losses due to food spoilage

R. D. STANGE, M. G. JOHNSON, and L. D. WITTER

Bacterial growth on solid surfaces is of immense economic importance. On the one hand it causes huge losses, spoiling meat, fish, poultry, cheese, fruits, and vegetables; destroying house paints and industrial fabrics; and decaying teeth.

On the other hand, some bacterial growth is desirable and even necessary in the surface ripening of cheese, the production of vinegar in a continuous generator, and the treatment of sewage in a trickling filter system.

Despite the importance of bacterial growth on solid surfaces, very little effort has been directed toward describing such growth and the factors influencing it. A project in the Food Science Department was therefore designed to examine this area.

Examination of colonies

The growth of a number of bacterial colonies on laboratory media was completely described by measuring the changes, over a period of time, in colony diameter, elevation profile, viable cells, volume, and cell density. In all colonies examined, the colony diameter increased linearly with time.

Even irregularly shaped colonies which have no measurable diameters followed the same growth pattern as circular colonies. Photomicrographs were taken of growing, irregularly shaped colonies, the pictures were enlarged to scale, and the areas occupied by the colonies were measured with a planimeter. The diameter necessary in a circular colony to produce the experimentally determined area of the irregular colony was calculated and was plotted with time. These pseudo-diameters of the irregularly shaped colonies increased linearly with time just as did the diameters of circular colonies.

The increase of diameter with time was chosen as the steady-state growth characteristic of bacterial colonies growing on a solid surface. Using this parameter, we were able

R. D. Stange is Research Assistant in Food Science and M. G. Johnson was formerly Research Assistant. L. D. Witter is Associate Professor of Food Microbiology.

to compare the growth rates of different bacteria on the same surface or of the same bacteria growing under different conditions.

Surface tension and colony growth

In one study, we determined the effect of surface tension on the colony growth of *Pseudomonas fluorescens,* a common contaminant of cottage cheese and butter.

Surface tension is measured in dynes per centimeter. (A dyne is the unit of force that would give a free mass of 1 gram an acceleration of 1 centimeter a second every second.) Most commonly used bacterial media have surface tension values between 70 and 50 dynes per centimeter.

Within this range of 70 to 50 dynes per centimeter, changing the surface tension values did not affect colony growth rate. Within the range of 50 to 32 dynes per centimeter, however, a reduction in surface tension stimulated growth rate.

One practical application of these results might be the reduction of surface tension in bacteriological plating media commonly used in tests for quality control. The consequent increase in growth rate of colonies would decrease the time of incubation before counting.

Bacterial growth on carrots

The principle of the steady-state increase in colony diameter with time was used to measure the growth of *Pseudomonas chlororaphis* on carrots. Whole carrots were pureed in a blender and solidified into a gel by the addition of agar. Colony diameters of the test bacterium increased at the rate of 0.079 millimeter per hour on the carrot puree agar.

The xylem (central portion) and the phloem (outside portion) of the carrot were separately blended into an agar gel. The steady-state growth rate of *P. chlororaphis* on the xylem puree agar was 0.077 millimeter per hour — about the same as on the whole carrot puree agar. On the phloem puree agar, however, the growth rate was only 0.056 millimeter per hour.

This slow growth rate indicated the absence of a nutrient desirable for growth of the test bacterium, rather than the presence of a growth inhibitor. If the phloem had contained a growth inhibitor, the growth rate would have been substantially less on whole carrot puree agar than on the xylem puree agar.

These results suggested that unsliced carrots would spoil less quickly than sliced carrots. Slicing carrots not only exposes the carrot portion more favorable for contamination growth, but also increases the surface on which the bacteria can operate.

The carrot puree agar surface was designed to serve as a model system of the carrot. However, colonies on the xylem of the carrot slices grew at a rate of 0.201 millimeter per hour, or about 2½ times as fast as those on a model puree system.

Growth at interfacial areas

A more subtle influence of solid surfaces is found in liquid solutions. Bacterial growth in liquids may be accentuated by an increased solid-liquid interfacial area (the area where the liquid comes into contact with the container or other solid). Both nutrients and bacteria are probably adsorbed and concentrated at the solid-liquid interfacial surfaces. This establishes an ideal microenvironment for bacterial growth. In fact, adsorptive forces explain why equipment becomes soiled and why scouring or rubbing is necessary to clean it.

A solid surface would not be expected to increase bacterial growth if the conditions in the liquid are already optimal for growth. The importance of the interfacial surface increases as available nutrients in the liquid decrease. In experiments with marine microorganisms, growth of the organisms was not influenced by a surface until the concentration of nutrients was less than 10 parts per million.

We examined the dilution of nutrients necessary to demonstrate the effect of solid surfaces on *P. chlororaphis* growth. Trypticase soy broth required a 1:10,000 dilution to 4 parts per million before growth was influenced by the surface. In a chemically defined broth, however, only a 1:10 dilution to 2,000 parts per million was enough to demonstrate the effect of the solid-liquid interface on growth. When at full strength, the chemically defined broth contained all the nutrients necessary for good growth, but apparently one nutrient was in low enough concentration to be easily diluted below the level for optimum growth.

Effect of container size

Diluted liquid solutions containing *P. chlororaphis* were stored in containers of varying size and the growth of the organism was measured. When soft glass, hard glass, and stainless steel containers were used, decreasing the size of the container increased the surface-to-volume ratio and thus increased the growth of the bacteria.

These results suggest that liquid foods may spoil faster when packaged in small containers than in large ones. If 1 gallon of liquid in a square container were distributed instead into 8 square pint containers, the available surface area would double, and so would the desirable microenvironment for bacterial growth.

The growth of *P. chlororaphis* was not accelerated by an increase in the surface-to-volume ratio when polyethylene containers were used or when soft glass containers were coated with a hydrophobic agent such as Siliclad. On surfaces poorly wetted by water, the attractive and repulsive forces known to act between discrete particles in the water phase and the solid surface are either balanced or favor repulsion. The ease of cleaning and consequent popularity of teflon-coated cookware attests to this property.

It may be that one of the most important future developments of sanitary engineering will be the impregnation or coating of equipment surfaces used in the processing of foodstuffs to decrease the possibility of contamination during processing.

CORN YIELDS ON NATRIC SOILS
After Varying Applications of Gypsum

J. B. FEHRENBACHER, T. D. HINESLY, P. E. JOHNSON, and B. A. JONES

Various methods of improving corn yields on "slick spots" or natric soils are being tested in south-central Illinois.

These soils were described in detail in the Winter, 1966, issue of Illinois Research. Briefly, their subsoils contain large amounts of exchangeable sodium, whose action creates a poor environment for root development. One of the chief disadvantages of natric soils is their low permeability. They dry out slowly in spring, but once they are dry, their moisture content cannot be easily replaced. These soils occupy over 380,000 acres in south-central and western Illinois.

It was thought that the productivity of natric soils might be improved by applications of calcium in the form of gypsum (calcium sulfate). Experiments to test this theory have been conducted on Huey silt loam on the Newton Agronomy Field, and on Piasa silt loam and the associated Herrick silt loam in Christian and Montgomery counties.

Variables tested at Newton

On the Newton Field, several variables have been tried: different methods and rates of applying gypsum, different degrees of disturbing the subsoil and mixing the gypsum with it, and different spacings of tile. These tests have been conducted in two different experiments.

One method of adding gypsum was to apply it to the plow layer and mix it with the surface ½ foot of soil. A second method was to chisel the gypsum 2 feet deep into the soil. The chisel tracks were 2 feet apart in both a north-south and an east-west direction.

In a third method of applying gypsum, the top 3 feet of soil was removed with a backhoe and the gypsum was thoroughly mixed with it. On some plots, the top 3 feet of soil was mixed without gypsum.

On the surface and chiseled plots, the rate of gypsum application was 10.7 tons per acre. We calculated that this was the amount necessary to replace the exchangeable sodium in the top 2 feet of soil. The rate on the mixed plots was 27.8 tons — enough to replace the sodium to a depth of 3 feet.

Tile spacings of 10, 30, and 60 feet were tried in the mixed plots. All tiling in the chiseled and surface-treated plots was spaced 30 feet apart. (Some of the surface-treated plots were left untiled as a check.)

All plots received 160 pounds of nitrogen per acre each year, as well as the amounts of phosphorus and potassium called for by soil tests. Adapted hybrid corn was grown.

Only heavy applications successful

Over a three-year period, 1964-1966, corn yields were not significantly increased by gypsum applied to the plow layer or chiseled 2 feet deep into the soil. Gypsum mixed with the soil to a depth of 3 feet did significantly increase yields (Table 1). The difference between the yields for this treatment and yields for the next-best treatment (chiseled to 2 feet) was 44.4 bushels per acre.

On plots where gypsum was mixed with the soil to a depth of 3 feet, 1964-1966 average yields were highly significantly greater than on plots where the soil was mixed without gypsum (Table 2). Tilth of the mixed soil was improved by gypsum, but deteriorated without gypsum. Tile spacings (10, 30, and 60 feet) did not significantly affect yields on the mixed plots.

Gypsum tried on farms

During 1963 and 1964 gypsum was tried on two farms — one in Christian County near Harvel, the other

Table 1. — Corn Yields From Various Treatments at Newton, 1964-1966

Line	Gypsum per acre	Depth of soil disturbance	Tile spacing	Corn yields per acre 1964	1965	1966	Aver.
	tons	*feet*	*feet*	*bushels*			
1	None	Surface ½	30	47.9	41.5	33.6	41.0
2	10.7	Surface ½	None	45.4	42.4	26.1	38.0
3	10.7	Surface ½	30	63.4	39.8	35.4	46.2
4	10.7	Chiseled 2	30	70.0	62.2	38.0	56.7
5	None	Mixed 3	30	67.8	50.2	48.6	55.5
6	27.8	Mixed 3	30	93.2	113.7	96.4	101.1

Comparisons of treatments

Item A		Item B	Aver. yields per acre Item A	Item B	Diff.
			bushels		
Tile 30ft. (line 3)	vs.	No tile (line 2)	46.2	38.0	8.2
Gyp. surface ½ft. (line 3)	vs.	No gyp. (line 1)	46.2	41.0	5.2
Gyp. chiseled 2ft. (line 4)	vs.	No gyp. (line 1)	56.7	41.0	15.7
Gyp. chiseled 2ft. (line 4)	vs.	Gyp. surface ½ft. (line 3)	56.7	46.2	10.5
Gyp. mixed 3ft. (line 6)	vs.	Gyp. chiseled 2ft. (line 4)	101.1	56.7	44.4*

* Difference significant at 5-percent level.

in Montgomery County near Coffeen. On both farms the tests were conducted on Piasa silt loam (a natric soil) and the associated Herrick silt loam.

Test plots, 20 by 30 feet, were set up in the fall of 1962. Three levels of gypsum — 2, 4, and 8 tons — were compared with no gypsum on each soil at each location. Gypsum was applied to the plow layer of some plots, and was chiseled in 2 feet deep on other plots. Chisel tracks were 2½ feet apart.

In addition, another set of plots was tiled at a depth of 2 feet with a 2-inch plastic tube perforated with $\frac{1}{16}$-inch holes. This set of plots received 8 tons of gypsum per acre.

All plots were fertilized in 1963 and 1964 with 150 pounds of nitrogen per acre, plus the amounts of phosphorus and potassium indicated by soil tests. Adapted corn hybrids were grown.

Yields not affected by gypsum

Regardless of rate or method of application, gypsum did not significantly affect corn yields on either Piasa or Herrick silt loam. Yields on Herrick were highly significantly greater than those on Piasa. Also, yields on Piasa were highly significantly higher at Harvel than at Coffeen. The Piasa soils at the two sites appeared to be similar, but weeds may have reduced yields at Coffeen.

In general, yields were considerably higher in 1963 than in 1964. Although not given in Table 3, yields on tiled plots were not significantly greater than those on untiled plots.

It may be that the gypsum rates in these field trials were not great enough. In view of the results at Newton, however, it appears unlikely that yields on Piasa would have been increased by greater amounts of gypsum applied to the surface or chiseled in 2 feet deep.

Considering all of the tests discussed here, it appears that rather large amounts of gypsum must be thoroughly mixed with the subsoil to significantly increase corn yields on natric soils.

Table 2. — Corn Yields on Mixed Plots at Newton, 1964-1966

Line	Gypsum per acre	Depth of soil disturbance	Tile spacing	Corn yields per acre 1964	1965	1966	Aver.
	tons	feet	feet	bushels			
7	None	Mixed 3	10	52.5	46.2	36.6	45.1
8	None	Mixed 3	30	67.8	50.2	48.6	55.5
9	None	Mixed 3	60	55.8	33.4	39.4	42.9
10 (Aver.)	. .	. . .	. .	58.7	43.3	41.5	47.8
11	27.8	Mixed 3	10	89.8	100.6	99.2	96.5
12	27.8	Mixed 3	30	93.2	113.7	96.4	101.1
13	27.8	Mixed 3	60	73.7	77.0	88.1	79.6
14 (Aver.)				85.6	97.1	94.6	92.4

Comparisons of treatments

Item A		Item B	Aver. yields per acre Item A	Item B	Diff.
				bushels	
Mixed 3ft. with gyp. (line 14)	vs.	Mixed 3ft. without gyp. (line 10)	92.4	47.8	44.6**
Tile 10ft. (lines 7 and11)	vs.	Tile 60ft. (lines 9 and 13)	70.8	61.2	9.6
Tile 30ft. (lines 8 and 12)	vs.	Tile 60ft. (lines 9 and 13)	78.3	61.2	17.1

** Difference significant at 1-percent level.

Table 3. — Corn Yields on Two Soils at Two Locations With Various Rates of Gypsum and Two Methods of Application, 1963-1964

Tons per acre of gypsum	Corn yields, bushels per acre: Gypsum in surface ½ ft. 1963	1964	Aver.	Gypsum chiseled to 2 ft. 1963	1964	Aver.
Herrick silt loam (Harvel)						
0	123.4	72.6	98.0	138.2	93.6	115.9
2	135.1	60.7	97.9	108.5	94.0	101.3
4	125.9	73.0	99.5	126.4	82.4	104.4
8	126.8	88.8	107.8	116.6	71.6	94.1
Average	127.8	73.8	100.8	122.4	85.4	103.9
Herrick silt loam (Coffeen)						
0	108.7	82.4	95.6	100.8	82.1	91.5
2	111.8	80.4	96.1	103.5	98.7	101.1
4	95.4	69.7	82.6	83.1	57.8	70.5
8	101.5	86.5	94.0	104.5	68.6	86.6
Average	104.4	79.8	92.1	98.0	76.8	87.4
Piasa silt loam (Harvel)						
0	52.9	28.8	40.9	31.1	39.5	35.3
2	52.5	31.5	42.0	49.3	40.0	44.7
4	65.3	44.9	55.1	41.2	36.6	38.9
8	39.4	38.6	39.0	48.6	30.2	39.4
Average	52.5	36.0	44.3	42.6	36.6	39.6
Piasa silt loam (Coffeen)						
0	10.2	7.1	8.7	18.5	7.4	13.0
2	4.0	4.6	4.3	16.3	3.7	10.0
4	16.8	4.1	10.5	10.1	4.9	7.5
8	23.8	10.2	17.0	11.4	4.0	7.7
Average	13.7	6.5	10.1	14.1	5.0	9.6

J. B. Fehrenbacher is Professor of Pedology; T. D. Hinesly, Assistant Professor of Soil Management Extension; P. E. Johnson, Assistant Professor of Soil Fertility; B. A. Jones, Professor of Agricultural Engineering.

SOYBEAN YIELDS:

How they are affected by correction of manganese deficiency on sandy soils

D. L. MULVANEY and J. W. PENDLETON

OF THE 17 elements that crops need for growth and reproduction, 10 are needed in only small amounts and are called minor elements or micronutrients. These are magnesium, sulfur, zinc, copper, boron, manganese, iron, molybdenum, chlorine, and sodium. The major elements, so-called because they are needed in larger amounts, are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, and calcium.

Micronutrients usually adequate

Illinois farmland is relatively young, compared with most agricultural regions of the world, and most Illinois soils are still apparently well supplied with the micronutrients. Usually nitrogen, limestone, phosphorus, and potassium are the only soil additions that farmers need to be concerned with. Soil tests serve as guidelines for applying all of these materials except nitrogen.

As cropping intensity increases, however, more crops may be deficient in minor elements. The Department of Agronomy is alert for the appearance of such problems and is using a mass spectrograph to analyze plant tissues suspected of nutritional deficiencies. Thus far, no soil test for the micronutrients is available to farmers.

Why study was started

Although micronutrient deficiencies are rare in Illinois, they do exist. One example is found in a large area of high pH sand in the Green River valley, Whiteside County. Soybeans grown there have shown visible signs of manganese deficiency.

A series of field experiments was conducted on the farm of Ed Hoyle, Harman, over a period of several years, to learn more about correcting manganese deficiency in soybeans. Four variables were tested:

1. Method of application: Foliar vs. row.

2. Time of foliar application: Early (plants 10 inches tall) vs. late (20 inches).

3. Rate of foliar application: 5, 10, and 20 pounds per acre of manganese sulfate.

4. Soybean varieties: Chippewa, Lindarin, Harosoy, Hawkeye, Shelby.

Some results

Row and foliar applications were compared in a two-year study with the Harosoy variety. The row application consisted of 30 pounds of manganese sulfate applied at planting; the foliar application, 10 pounds of manganese sulfate applied when the plants were 10 inches tall. Foliar applications produced yields 7 bushels greater than on the check plots. Row applications increased yields by only 2 bushels.

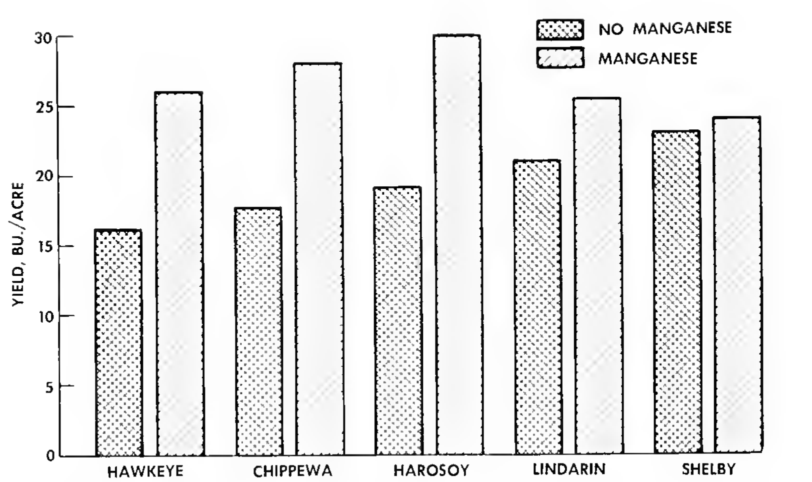
Because of the superior effectiveness of foliar applications, we began a three-year study to determine the best rate and time of making such applications. The highest yield was obtained from spraying 10 pounds of manganese sulfate in 10 gallons of water when the plants were 10 inches tall (see table). Spraying was far more effective on plants 5 to 10 inches tall than on plants 15 to 20 inches tall. Spraying both early and late was no more effective than a single early spraying.

In another experiment, lasting two years, variety response to manganese was tested. As shown in the chart, varieties differed widely. Hawkeye, Chippewa, and Harosoy showed a yield increase of about 60 percent; Lindarin, 22 percent; and Shelby, little response at all.

The differences noted for time, rate, and method of manganese application and for variety reaction illustrates the difficulty of studying minor elements, even where a deficiency is known to exist.

How Rate and Time of Foliar Applications of Manganese Sulfate Affect Soybean Yields

Rate of $MnSO_4$, lb./acre	Plant height, in.	Yield, bu./acre
None (check)	..	19.7
5	10	26.8
10	10	28.8
20	10	25.2
10	20	23.0
20	20	21.3
10+10	10 and 20	29.1



Response of five soybean varieties to a foliar application of 10 pounds of manganese sulfate on Selma fine sandy loam.

D. L. Mulvaney is Assistant in Soil Fertility; J. W. Pendleton is Professor of Agronomy.

New Information About Greenhouse Tomatoes

J. W. COURTER

FARMERS in southern Illinois can profit from tomatoes grown in either plastic or glass greenhouses. Tests of more than 50 varieties since 1962 at the Dixon Springs Agricultural Center have shown that the best varieties can produce more than 100 tons per acre. These are special varieties developed for the greenhouse environment.

Conditions of experiment

In the Dixon Springs trials five- to seven-week-old plants were set in the greenhouse during the last week of August or the first week of September for the fall crop, and during the first two weeks of January for the spring crop. The fall crop was harvested from mid-October to early January; the spring crop, from late March through early July.

The spacing was 4.5 square feet per plant (9,680 plants per acre). As far as possible, day temperatures were maintained at 70° to 85° F., with the lower temperatures during cloudy days. Flower clusters were mechanically vibrated four to six times each week to insure pollination.

Recommended varieties

The performance of the four best varieties is shown in Table 1. Production is lower in the fall than in the spring because of a shorter growing and harvest period and less light.

Michigan-Ohio Hybrid is the best red-fruited variety; Ohio WR-25 and Ohio WR-7 are the recommended pink-fruited varieties. Ohio WR-25, a new variety, has yielded as well as or better than the older WR-7 and has consistently produced higher grade fruit. P-115 is an experimental pink variety.

For two crops per year, the four varieties in Table 1 have averaged well over 100 tons of tomatoes per acre. Yields of over 100 tons per acre (20 pounds per plant) have been produced in a single crop, but they are the exception rather than the rule. A combined total of 20 pounds from each 4.5 to 5.0 square feet of greenhouse from the fall and spring crops is attainable with good management, and is a realistic level of commercial production.

Several Canadian and English varieties in the tests produced very small fruit and low yields. Commercial garden varieties did not perform as well as the special greenhouse varieties.

Number of flowers producing fruit

During 1966 records were kept for every flower on five plants each of Ohio WR-25 and Michigan-Ohio Hybrid. As shown in Table 2, 73.5 percent of the flowers on the WR-25 variety produced fruit, for an average yield of 16.88 pounds per plant. Only 60.9 percent of the flowers on the Michigan-Ohio Hybrid matured tomatoes.

Studies of the factors limiting fruit set and production of greenhouse tomatoes are in progress.

Table 1. — Yield Summary of Selected Tomato Varieties in Greenhouse Production Tests

Variety	Marketable yield, lb. per plant					U.S. No. 1 fruit		Av. yield, tons/A.
	1962	1963	1964	1965	1966	Pct. of yield	Av. size, oz.	
Fall Crop								
Michigan-Ohio Hybrid	8.3	10.7	12.1	13.3	6.5	72	5.8	49.4
Ohio WR-25		8.2		13.1	7.0	90	5.7	45.5
Ohio WR-7	8.0	10.3	11.5	10.0	4.8	70	6.4	43.1
P-115[a]	6.7	6.7	10.4	14.4	4.9	83	5.2	41.6
Spring Crop								
P-115[a]		18.8	20.7		15.1	73	6.3	79.0
Ohio WR-25			18.9	17.9	15.0	62	6.9	75.1
Michigan-Ohio Hybrid	13.8	16.9	21.5	17.8	14.6	59	5.9	73.3
Ohio WR-7	10.4	12.8	20.2	14.1	12.4	57	6.8	60.8

[a] Experimental variety from Purdue University not available commercially.

Table 2. — Yield by Cluster for Five Ohio WR-25 Plants, Spring, 1966[a]

Cluster	Number of flowers[b]	Pct. setting marketable fruit	Av. size, oz.	Pounds harvested	Harvest period	Av no. days, flowering to harvest
1	6.0	85	4.5	1.40	4/18 to 5/16	75
2	8.0	90	6.4	1.83	4/25 to 5/13	76
3	6.6	70	5.3	1.33	4/24 to 5/31	73
4	17.4	57	4.0	2.37	5/8 to 6/25	73
5	8.0	50	6.5	1.56	5/12 to 6/6	65
6	8.2	72	6.0	2.11	5/16 to 6/27	64
7	6.8	54	6.9	1.56	5/26 to 6/16	62
8	5.0	86	5.1	1.58	6/6 to 7/6	65
9	4.6	86	6.1	1.50	6/16 to 7/11	59
10	3.5	100	5.4	1.17	6/20 to 7/11	56
11	3.0	58	3.7	.47	6/30 to 7/8	53
Total	77.1			16.88		
Average	7.1	73.5	5.4	1.53		65.5

[a] Planted January 7, 1966.
[b] Number of flowers reaching anthesis by May 16, 1966; average for five plants.

J. W. Courter is Assistant Professor of Horticulture.

The Problem of Hunger in the World

K. E. GARDNER

According to some experts, the present world population of 3 billion will be doubled by the end of this century. I doubt whether the increase will be quite that great, but we can undoubtedly expect a very serious quarter century ahead, during which the problems of hunger and malnutrition could reach disaster proportions.

The problem of hunger is qualitative as well as quantitative. In the infant, child, and adolescent, the principal problem across the world is an inadequacy of protein. For older people the problem is often more a matter of calories, although high-quality protein again is important for maximum efficiency in utilization of available calories.

Supplying protein

The provision of high-quality protein (one with a good balance of amino acids) reduces the total need for protein. In other words, we can get along on less soybean protein than corn protein, and less animal protein than soybean protein.

Immediately we may assume that more animal protein is needed. However, when we consider the built-in inefficiencies of growing crops, feeding them to animals, and then using the animal products, we realize that animal products cannot be very important in many areas of the world. The problem instead is to supply as good a protein as is possible under the circumstances.

Corn, for example, may become a relatively good source of protein, thanks to the development of strains that are high in lysine, one of the amino acids. Up to now, the low protein content of corn has been its greatest single defect as a human food.

Wheat contains 70 percent more protein per pound than the traditional corn grain, and the wheat protein is of somewhat better quality. This quality can be improved still further by adding lysine, although the level will not be quite that of typical animal protein. Under the "Food for Peace" program, the United States is shipping several hundred million bushels of wheat to underdeveloped countries every year.

Fish protein already helps nourish coastal or river people. New developments in processing fish meal may greatly help to feed more of the world's undernourished.

More inputs needed

A common misconception is that the developing countries' inability to feed themselves is due entirely to ignorance. I should like to point out, however, that most countries do not have nearly as good natural conditions as we do. The soils in tropical countries, especially, are much poorer than those in the temperate zone. In addition, sudden deluges can erode cultivated land, and then an unexpectedly long dry period can work havoc with growing crops. Plant and animal diseases are also much harder to control in these countries. Furthermore, some tropical climes are very debilitating. A malnourished, unhealthy man is not an efficient worker.

Dr. T. W. Schultz of the University of Chicago believes that the farmers in the developing countries may be operating at just about their maximum food-producing potential, considering the inputs at their disposal. Real benefits can come about only by adding new inputs, such as fertilizer; improved seeds and livestock; better control of weeds, pests, and diseases; irrigation and soil conservation; improved tools; improved methods of harvesting, storage, and marketing; and, of course, better education.

Programs to help

What we in the West need to do is to find ways of helping the underdeveloped countries to help themselves. A start has been made through the Agency for International Development (AID). The University of Illinois is cooperating with AID by helping to develop two agricultural universities in India and one in Sierra Leone. Other universities are cooperating with AID in similar fashion.

Illinois staff members in India have demonstrated that crop yields can be doubled by using good seed, fertilizer, and proper weed control. Experimental work is now in progress to develop high-yielding strains of corn and soybeans for India. Improved strains of rice and oil palm trees are being distributed over Sierra Leone. Soil studies now under way in both countries will form the basis for suitable soil treatment. Weed control and pesticide use are being promoted. Better methods of reaching illiterate farmers with progressive ideas are being developed. These are but a few examples of Illinois's overseas activities.

In addition to AID, other agencies are "in the act," including private foundations and industry, churches, the Peace Corps, the National Institutes of Health, the United Nations, and many other governments.

All together, however, these programs are pitifully small considering the need. In my opinion, a whole series of basic research institutes, similar to our own agricultural experiment stations, should be established around the world and staffed with the best available talent.

With this great need for research, the supply of competent workers is deplorably short. We also need more facilities and operating funds to mount a world-wide food offensive. The problems facing agriculture are monumental; how fast can we mobilize to solve them?

K. E. Gordner is Associote Deon ond Director of Resident Instruction, College of Agriculture.

Communities need to plan for RECREATIONAL FACILITIES

JERRY R. VAN METER

THE DEMAND for parks and other recreational facilities is far outstripping the supply. The reasons are obvious: more people, more money, more time, and greater urbanization, combined with a lack of comprehensive planning at all levels of government.

About 90 percent of all Americans participated in some form of outdoor recreation in the summer of 1960. All together, they took part in one activity or another on 4.4 billion occasions. It is anticipated that the total will be 6.9 billion by 1976, and 12.4 billion by the year 2000.

Three-quarters of the people will live in metropolitan areas by the turn of the century. They will have the greatest need for outdoor recreation, and their need will be the most difficult to satisfy. Parks and other recreational areas are urgently needed both in and near the large population centers.

Illinois lags behind

According to a number of studies, Illinois lags far behind the rest of the country in public parks and outdoor recreational facilities. While 12.2 percent of the land in the nation is devoted to public outdoor recreation, only 1.6 percent (565,178 acres) of the land in Illinois is put to this use. This acreage amounts to only 0.05 percent of the public recreation land in the country and is the lowest acreage per capita in any of the states. Illinois's state park system also ranks lowest in the country, both in acreage per capita and in facility development.

At the same time Illinois is one of the most populous states, ranking first in the Midwest and fifth in the nation (according to 1965 estimates). Over 80 percent of the Illinois population is urban. There is a surging demand for all types of outdoor recreation, particularly that in or near water.

Include recreation in planning

Comprehensive planning of land use is necessary to provide adequate recreation facilities. Often such facilities can be included in multiple-use areas. Plans for urban renewal or for water resource development, for example, should include a consideration of recreation needs.

Water is the focal point of outdoor recreation, not only for water sports, but for such other activities as camping or picnicking. Recreational use of water areas developed by the Corps of Engineers almost tripled from 1954 to 1964, going from 54 million visits a year to 156 million visits. Forty-three Corps-built lakes each had attendance of over a million in 1964.

Although the chief reason for providing outdoor recreation is its contribution to social and individual welfare, it also brings about economic benefits. Recreation areas enhance a community's desirability as a place to live and this in turn increases land values. In some underdeveloped areas, recreation can bolster the local economy. People seeking the outdoors spend about $20 billion a year.

Research is needed

As outdoor recreation increases in importance, it will need more land, but much of this land can be used, and will be demanded, for other purposes. Although there can be no doubt that recreation is an important use of land, there has been little research to provide basic facts on the values of outdoor recreation to our society. Such facts need to be established so that resources can be wisely allocated. More must be known also about management techniques, so that the maximum social and economic benefit can be realized from these resources.

This research gap is now being bridged by many land-grant universities.

Many will be involved

Research and planning need to be followed by funding and implementation. Certainly many individuals and groups will participate in all these activities. Private enterprise is encouraged to supply facilities in areas where demand is high. State and federal agencies are also doing a great deal.

Important though these contributions are, the final responsibility for providing adequate facilities falls upon local government. It is at the local level that the needs of the people can best be determined. For that reason, the Cooperative Extension Service of the University of Illinois has made park and recreation educational services available to counties, cities, villages, planning boards, interested groups, and others.

Illinois is fortunate in having excellent legislation enabling local governments to organize for and implement a park and recreation program. Park districts and conservation districts are good examples of programs that have developed from this legislation. However, much more can be done. Educational programs are needed for combining enabling legislation with park planning and financial assistance.

A good start for any community would be to obtain the following booklets:

Federal Assistance in Outdoor Recreation
Superintendent of Documents
Washington, D.C. 20402 (35c)

Federal Programs for Individual and Community Advancement
U.S. Department of Agriculture
Washington, D.C. 20250 (free)

County Action for Outdoor Recreation
National Association of Counties
1001 Connecticut Avenue
Washington, D.C. 20036 (25c)

Jerry R. Van Meter is Outdoor Recreation Specialist, Cooperative Extension Service.

FARM BUSINESS TRENDS

Illinois farmers seem to have some important advantages in corn production. They have been increasing production faster than farmers in most other states. This can be shown by comparing average figures for 1964-1966 with those for 1954-1956.

During the past three years the average annual production of corn in this state was 831 million bushels, 58 percent more than the three-year average 10 years earlier.

The latest three-year U. S. average production was 3,886 million bushels, which is 35 percent more than 10 years before.

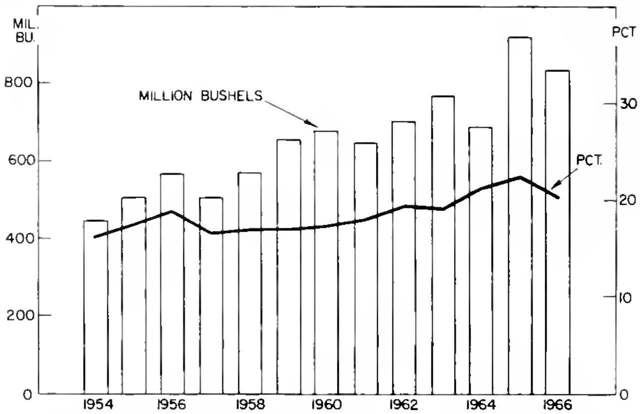
Illinois produced 21.4 percent of the national corn crops of the past three years compared with only 17.5 percent a decade earlier.

In 1964-1966, Illinois farmers harvested an average of 9.8 million acres of corn per year. This was 11 percent *more* than the average acreage harvested in 1954-1956.

Over the same 10-year period the national average acreage of corn decreased from 67.3 million acres to 55.8 million. The 1964-1966 acreage was 17 percent *less* than that of 10 years before.

The latest three-year average yield per acre for Illinois is 84.6 bushels, which is 46 percent more than for the three years a decade earlier.

The latest three-year average yield for the United States is 69.5 bushels per acre, 62 percent more than 10 years before. Thus the percentage increase in yields has been greater for the United States as a whole than for Illinois. The gain in bushels, however, has been the same in Illinois as in the nation as a whole — 26.5 bushels.



Corn production in Illinois: bushels and percent of national total, 1954-1966.

One might surmise that, since corn acreage is increasing in Illinois, some of the added acreage is below average quality. With acreage elsewhere decreasing, we may suppose that some of the lower-yielding lands are no longer being used for corn.

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Fall, 1967

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Historic costumes belonging to the Department of Home Economics have special significance in the University's centennial year (page 10).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell . . . . Director

Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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NEWS AND VIEWS

Funds, Facilities, and the Future

As in other states, the research conducted by the Illinois Agricultural Experiment Station is supported by public and private funds from many sources. State funds appropriated by the legislature constitute about 55 percent of the total support. Nearly 25 percent of the agricultural research budget comes from the U.S. Department of Agriculture, largely as grants whose size is determined by the number of farms and farmers in Illinois. Research grants from other federal agencies represent about 10 percent of the budget. The remaining 10 percent is derived from grants from private sources and from the sale of crops, animal products, and livestock produced as part of the research program.

Recent advances in physics, chemistry, and other fields of science have been accompanied by profound changes in the research techniques and equipment that are now available for a detailed and penetrating attack on agricultural problems. Sophisticated electronic measuring devices, esoteric chemicals, high-speed computers, radioactive isotopes, and precisely controlled environmental chambers for growing plants and animals are among the research tools that must be available if the expanding knowledge from the world of science is to be exploited in agricultural research.

Rising costs and pressing building needs generated by expanding enrolment at this and other public institutions accentuate the problem of increasing and upgrading the facilities and equipment necessary for productive, forward-looking agricultural research.

The need for persons capable of solving agricultural and food-production problems was emphasized in the report entitled "The World Food Problem," recently published by the President's Science Advisory Committee. It is clear, however, that only if we can provide modern facilities and equipment, as well as opportunities for stimulating and rewarding careers, can we attract the caliber of scientific staff that will be required to help a hungry world feed itself.

Decisions made now on building priorities and agricultural research facilities will largely determine our ability to meet the need for research personnel and programs after 1980. High priority must therefore be given to developing facilities and support that will keep agricultural research modern and productive. — *M. B. Russell*

HIGH-LYSINE CORN:

How Will It Affect Illinois Livestock and Feed Industries?

JOHN T. SCOTT, Jr.

THE DEVELOPMENT of high-lysine (modified-protein) corn by plant breeders is likely to have far-reaching effects on both human and animal nutrition.

Since high-lysine corn provides more total protein, as well as more lysine, than regular corn, it can prove a boon in those parts of the world where the human diet is inadequate in both quality and amount of protein. It will be particularly valuable in Central and South America, the Philippines, and parts of Africa and India where corn is an important part of the diet.

In the United States, the greatest value of high-lysine corn will be as a replacement for both regular yellow corn and protein supplement in animal rations. High-lysine corn is expected to find its greatest domestic use in swine rations, since hogs require a high level of lysine.

Cattle can take various sources of protein and manufacture their own specific amino-acid requirements. Thus, in cattle rations, the value of high-lysine corn will be no greater than its general protein and carbohydrate substitution ratio with other sources of feed energy. Also, high-lysine corn is little more desirable in poultry rations than regular yellow corn, but for a different reason. Poultry require a high level of the amino acid methionine, and high-lysine corn has no more methionine than regular yellow corn.

Comparative feed costs

Since most of the domestic demand for high-lysine corn will come from hog producers, it is important to know how great a premium they can pay for this corn and still keep ration costs at a minimum.

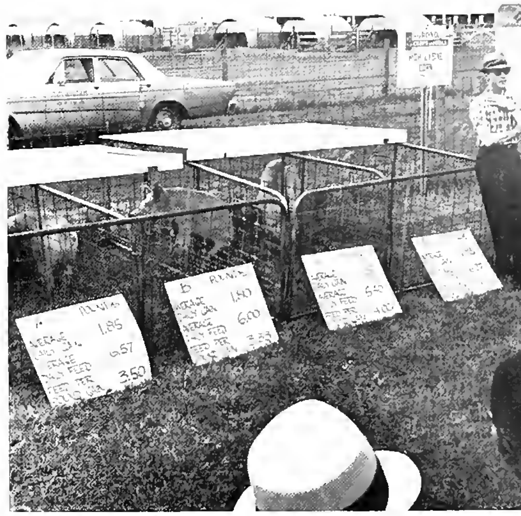
Minimum-cost linear programs therefore were formulated and calculated to determine how much high-lysine corn would be demanded at various prices of high-lysine corn relative to different prices of regular yellow corn and soybean meal. The regular corn and soybean meal were chosen as references because they are the dominant feedstuffs used in Illinois hog production. The range of prices investigated took in the high and the low prices for both feeds since 1950.

The linear programs included data on the amounts of specific amino acids and other nutrients that the three feedstuffs contributed to the swine ration. Two protein levels were used: the 12-percent ration which is widely used for finishing-fattening pigs, and the 16-percent ration which is recommended for growing pigs. Since additives for minerals, vitamins, and antibiotics are needed regardless of protein source and would have little effect on the program results, these ingredients were not included in the linear programs.

The LP90 linear programing routine was used on the University of Illinois IBM 7094 computer to find the least-cost rations.

Substitution of high-lysine corn

So long as soybean meal costs substantially more than corn on a pound for pound basis (as one might always expect), high-lysine corn will demand a higher price than regular yellow corn and still replace some or all of the regular corn and part of the soybean meal. Over a range of prices, high-lysine corn will be substituted for regular yellow corn until all of the regular corn is replaced.



In Illinois the chief value of high-lysine corn is in hog rations. Results of feeding trials with hogs are here being demonstrated during Agronomy Day.

In none of the formulations did high-lysine corn completely replace soybean meal. There are still a few amino-acid requirements which cannot be wholly met by high-lysine corn, even in the 12-percent ration. But since high-lysine corn is about 12 percent protein, it meets the percentage requirement for protein in the finishing-fattening ration.

Obviously high-lysine corn cannot supply all the protein for the 16-percent ration, but it goes much further than the regular yellow corn, which usually has a protein content of about 9 percent. Therefore, in the 16-percent ration, all the regular yellow corn will be replaced by high-lysine corn at a price slightly above that of regular corn.

The median price for regular yellow corn since 1950 is \$1.25. At this price, it will be replaced in the foregoing rations by high-lysine corn priced at about \$1.32 a bushel.

Implications for corn producers

On a per-acre basis, most production costs are about the same for high-lysine corn as for regular corn. When high-lysine seed becomes avail-

John T. Scott, Jr., is Associate Professor of Farm Management.

able, it is likely to cost more than regular seed for some time to come. This may be slightly offset by a lower fertilizer requirement because of lower yields.

If high-lysine corn is to bring a higher price than regular corn, it must be handled and marketed as a separate commodity. There will certainly be a minimum amount of corn that a producer must expect to deliver to get a premium price. This may discourage the small producer from growing high-lysine corn.

To justify a shift to high-lysine corn from regular corn production, the high-lysine corn would have to yield at least 95 percent as much as regular corn. This is assuming that high-lysine corn with an average price of $1.32 will replace regular yellow corn at an average price of $1.25, and also that per-acre production costs are about the same.

If high-lysine corn decreases the demand for soybeans, some acreage may be diverted from soybeans to the high-lysine corn. However, both soybean and corn producers will probably be affected less than hog producers and the feed industry.

Implications for hog producers

Swine producers who grow most or all of their own corn can be expected to shift to high-lysine corn sooner than other corn producers. Hog men will not be affected by the additional marketing costs which will be associated with high-lysine corn. Also, because the use of high-lysine corn will reduce the cash outlay required for supplements and possibly interest cost on money, some hog producers may shift to high-lysine corn even with comparable yields below the 95-percent level necessary for equal feed replacement value.

A small cash outlay would still be required for vitamin and antibiotic supplements and for a small amount of protein supplement in the growing ration.

The development of high-lysine corn could slow down the impetus toward factory-type swine production units, where all feed is purchased. Because marketing costs will be higher for high-lysine corn than for regular yellow corn, the swine producer who buys all his feed will be at a disadvantage compared to the one who raises his own corn.

Effects on feed companies

Many feed companies now have large investments in plants and equipment for formulating, producing, and delivering protein supplements for swine. A good share of the payroll also depends on swine supplements.

If high-lysine corn became the main source of carbohydrates, it would also be the main source of protein. Swine supplements mixed off the farm likely would be mostly the antibiotic and premix types. Drug companies might service hog producers as well as feed companies do now.

This means that many feed companies would lose 50 percent or more of their business. They would have to make major adjustments in mill investment, delivery equipment, and employment. Forewarning of the magnitude of these adjustments should allow management enough time to make orderly changes, with possible expansion in other lines of activity.

Elevators and grain handlers

Since high-lysine corn looks almost like regular yellow corn, the marketing channels will have to handle this new product with special care if there is to be a price differential. An inexpensive test for high-lysine corn has not yet been developed.

If an elevator operator is to buy high-lysine corn as a separate product, he has two alternatives. He can rely on the farmer-producer's integrity, or he can contract for production, retaining control of seed sales and field inspections to assure purchase of a high-lysine product.

Where will the elevator sell the product? The early market channels will probably flow from elevator to local hog producers; from elevator to elevator and then to local hog producers; or from elevator to feed mill to factory-type hog producers.

Some factory-type hog producers may contract with one or more local grain farmers for high-lysine corn production to meet their feed requirements. This procedure would completely bypass both the elevator and the feed companies.

Since hog production is concentrated heavily in northwestern Illinois, the problem of handling high-lysine corn will have to be faced by elevators in that area sooner than in other parts of the state. At best, the market supply, demand, and price for high-lysine corn in relation to regular corn will vary widely for some time after general introduction of high-lysine corn.

Some future trends

In summary, the greatest initial benefit from high-lysine corn will accrue to hog producers who grow their own feed. By switching to high-lysine corn, they can lower their feed bill, assuming comparable yields with regular corn. The final benefit, after a period of adjustment, will accrue to pork consumers in the form of lower prices for pork.

Corn producers will receive little benefit. Most of them also produce soybeans, which may fall in total demand. The most serious adjustment will be required by feed companies and soybean processors who have relied on swine supplements for a substantial volume of their business.

At present plant breeders and chemical engineers are in a race that may affect the future of all grains. While breeders are trying to modify the amino acid composition of grains genetically, engineers are trying to reduce the cost of producing synthetic amino acids. The cost of several has been cut substantially in the past year.

If synthetic amino acids ever cost less than natural ones, they will be added to rations much as synthetic vitamins are added today. Grains will serve only as an energy source. What then will be the lowest cost source of energy? And what will be the place of soybeans and modified-protein corn in our agriculture?

AMPLE SUPPLIES OF SAFE WATER

Are Possible in Rural Areas of Illinois

RALPH C. HAY

A DEPENDABLE SUPPLY of good-quality water is a growing need in rural Illinois as well as in urban areas. Modern farm homes, rural nonfarm residences, concentrated livestock operations, fire protection, and recreation enterprises all increase the demand for safe water. At the same time, these same developments are adding to sewage and waste disposal, often creating serious pollution problems.

Illinois law requires that all public water supplies serving 10 or more homes be periodically tested for bacterial content at an Illinois Department of Public Health laboratory. (Regional laboratories are located at Aurora, Champaign, Rock Island, Springfield, and Carbondale.) Tests are also desirable for private water supplies, even those from deep drilled wells. It is important that the water be sampled carefully according to instructions. You can get help from county health districts and Cooperative Extension offices.

Wells are chief water source

Wells are the primary source of water in rural homes. Often, however, well water is polluted because the wells are too near livestock, sewer lines, or septic tank disposal fields, and also because the well top construction is poor. Some well tops can be rebuilt to seal against surface and subsurface drainage. In other cases, however, new wells in better locations are needed.

Older, large-diameter dug wells are especially susceptible to surface pollution. In several Illinois counties, water from more than 90 percent of the dug wells has been found unsafe for drinking.

Drilled wells that are properly developed and have pumps installed according to health standards usually produce safe water. In regions of the state where underground water is plentiful, good drilled wells should satisfy the increasing demand for water. In much of southern Illinois, however, and in some western and central areas, there is little or no good-quality underground water at reasonable depths.

Information on underground water supplies is available from the State Water Survey and the State Geological Survey, both at Urbana.

Surface water

In areas lacking well water, new sources of water collected on the surface must be developed. It is here that problems of pollution, water protection, and management are most difficult. Domestic supply from cisterns, common in rural homes, must at best be considered "raw water." Bacterial tests nearly always show filtered cistern water to be unsafe. For cistern water to test safe, it needs some kind of treatment, usually chlorination, that will kill water-borne bacteria.

Ponds or lakes can be a safe source of water. First they have to be fenced and the watersheds protected against pollution and erosion. Then the water requires settling, filtering, and treatment. To accomplish this, the farm family must become water plant operators. The Department of Public Health has developed plans for pond water systems that are safe though rather costly. Commercial package pond water-treatment units are also available.

Some farmers buying water

Increasing numbers of farm families are purchasing treated water. A surprising number buy water by the tank truck load, but rural water mains to bring safe water under pressure are much more satisfactory.

Farmers who live near towns or along existing water mains may arrange individually for extension of water mains to their homes. Cooperative action by a group of neighboring farmers, however, is usually needed. Some groups are forming rural water districts, planning water lines, and buying water from a nearby town.

Sewage disposal

Sewage and waste disposal has become increasingly complicated in rural areas, especially on farms with confinement livestock systems and recreation enterprises. Old undersized septic tanks and inadequate disposal fields create nuisances and pollution. Where soils are slowly permeable, disposal fields sometimes fail completely. Larger tanks and better designed disposal fields will suffice in favorable locations. But new methods such as sand filter beds for effluent disposal, and package sewage disposal plants and lagoons are coming into use.

The Farmers Home Administration makes loans for rural water systems and sewage-treatment plants designed by approved consulting engineers. As of July 1, 64 loans had been approved for such purposes in Illinois.

Planning important

Ample quantities of water are available in Illinois, but intelligent planning for increasing needs, careful management of water supply, and improved waste disposal are essential. Rural people are showing increasing concern and are taking action to maintain an abundant supply of clear, safe water in the future.

Ralph C. Hay is Professor of Agricultural Engineering.

C. J. McCord of Jasper County is justly proud of his forest plantations, which include white pine among several other species. Seventy-five percent of the white pines are alive and thrifty.

WHITE PINE PLANTATIONS:

Their Survival and Potential Use 15 to 19 Years After Planting

T. W. CURTIN

In the spring of 1948, C. R. Bell of Mason County planted 4,000 white pines that he had purchased from the Illinois Division of Forestry. Today, thanks to the good care he has given the plantation, he has a beautiful woodland on which 75 percent of the original planting remains. He has already realized some early returns from this plantation by selling unsheared Christmas trees. A good pruning job has insured future high-grade sawlogs.

The State of Illinois first offered trees to its landowners in 1932. That year's orders were for 12,200 trees. Since then, the state nurseries have distributed more than 200 million trees of many species. The total for the 1967 season surpasses the 8 million mark.

Unfortunately, not everybody who has ordered trees from the state nurseries has done as well as Mr. Bell. This is indicated by a study that was conducted in 1965-66 to answer some frequently raised questions about the success of the stock.

The study followed the history of 100 orders shipped between 1947 and 1951. A 5-year period was chosen so that results would not be distorted by unusual weather conditions in any one year. The period was far enough back that the trees had time to become firmly established by 1965.

How study was made

All orders for trees received by the Illinois Division of Forestry from 1947 to 1951 were punched on IBM cards. White pine orders were then sorted out from the other orders. The 778 cards for white pine were in turn thoroughly hand-shuffled to put them in random order. The cards were then printed out, and the first 100 individual farmers who had bought 1,000 or more trees were chosen. It was necessary to go through 349 cards to eliminate professional, governmental, and industrial plantings and obtain 100 orders believed to represent farm-type situations.

I collected the field data between November 26, 1965, and March 12, 1966, visiting the site of every plantation in the sample. All existing plantations were examined to determine the percent of survival, its present use, its potential, and the degree of injury from livestock, fire, and mismanagement.

Survival of trees

The degree of plantation success in the sample ranged from excellent to absolute failure. The failure or success depended partly on planting season, with most failures occurring in fall plantings. This is in line with the long-recognized fact that spring is a better planting season than fall. Today the Illinois state nurseries ship planting stock only in spring.

Other factors also revealed a relationship to degree of survival. Nearly half (47 percent) of the machine-planted trees survived, compared with only 29 percent of the hand-planted trees. Hand-planting can be as successful as machine work, but in general the planter gets tired late in the day and ceases to do the kind of work necessary for best survival.

For various reasons it was suspected that large orders would show a higher degree of success than the smaller ones. There was no indication, however, that the size of the order had any bearing on the percentage of surviving trees.

The planting layout appeared to make a difference. Of the trees planted in blocks, 44 percent survived as compared to only 32 percent for strip planting. Orders under-planted in hardwood stands were generally so poor that they were hard to find.

Changes in ownership or tenancy did not greatly affect plantation survival. On 19 plantations that had changed ownership at least once for a total of 44 owners, survival was 32 percent. Only five of the 24 tenant-operated plantations were still operated by the original tenant. The

T. W. Curtin is Assistant Professor of Forestry Extension.

average number of tenants for the 24 areas since the time of planting averaged 2.4 per tree order. Survival on the tenant-operated plantations was 39 percent.

Six orders involved both new owners and multiple tenancy. Sixty-three orders were on land still operated by the original purchaser and, surprisingly, averaged only 36 percent survival.

Age of the planting stock seemed important. The 3-0 stock (stock that had been in seedling bed 3 years and in transplant bed 0 years) averaged 30 percent survival as compared with 39 percent for the 2-2 stock (2 years in seedling bed and 2 years in transplant bed).

A complete list of the reasons that operators gave for planting failure would be quite long. However, the reasons can be grouped into several broad categories (some people gave more than one reason):

Lack of knowledge	38
Christmas trees harvested or stolen	16
Building or construction	6
Fire	5
Natural causes (drouth, disease, etc.)	5
Never planted the order	5
Unknown	20

A further grouping of "lack of knowledge" and "unknown" reasons would seem justified. This grouping would take in 61 percent of the reasons given for tree failures and would indicate that many more trees could have been saved if the operators had known more about tree requirements.

Although the harvesting of Christmas trees is a justifiable use, some plantations have been pilfered since they were 5 feet high. The theft of tops from large trees is a continuing problem.

Perhaps a lack of concern partly explains the lack of knowledge to which failures were attributed. Many of the plantation owners did not show much continued interest in the established plantations.

If one wants a good forest crop, one cannot expect to plant trees and then forget them. It is necessary to follow sound cultural practices and to keep livestock out of plantations.

Recreation is an important forest use. A Tazewell County Sportsmen's Club chose this plantation of white pine for their headquarters.

Future uses

A number of the plantation sites are already being used for purposes other than forest production. Other sites may be diverted to nonforest use in the future. Following is a summary of the owners' plans for their plantations:

Home sites and recreational areas	37
Farming (pasture, cropland, nursery production, livestock cover, windbreak, shelterbelts)	20
Forestry	42
Other (for sale)	1

Actually, the outlook for desirable forest stands is less than indicated above. Only 32 of the plantations were judged to be at all suitable for forest stands. Nine of these were marginal, some because they were on small areas and some because livestock would have to be removed to insure survival of the forest stand.

The potential does exist, however, for respectable white pine crops on the less valuable lands of Illinois. A periodic annual growth of 155 cubic feet for 45-year-old white pine on a medium site has been recorded in north-central Illinois (Lorenz and Jokela, 1957). Lorenz and Jokela further state that "sawtimber yields of white pine stands on sandy soils on Sinissippi Forest are expected to be at least twice those of native hardwood stands on good sites and at least five times those on poor sites over short rotations up to 80 years."

Other landowners besides Mr. Bell have been very successful with reforestation efforts. Chester J. McCord, Jasper County, has a very thrifty stand of white pines and other trees which has been well cared for. He controlled weeds and brush during the early years of the plantation and more recently has been pruning the trees to insure high-quality sawlogs in the future. A. C. Hart, a Cass County banker, also has an extensive, well-maintained stand of trees.

John Burke, a Lee County farmer, manages a stand that he helped his father plant. A large percentage of the trees survive, and continued care, including pruning, has made this one of the best stands encountered in the survey.

Although the white pine picture in Illinois today has many disappointing aspects, the future picture may improve. The recent surge in demand for outdoor recreation areas may inspire more landowners to plant white pines and other trees and to give the plantings the care they need.

The expense of planting and forgetting is great. Time and management are necessary to produce valuable forest stands.

After 100 years—

Agricultural Education and Research at the University of Illinois

The first university building.

PAUL W. REXROAT

A CENTURY AGO farming was, at best, a handicraft art that was passed on by example and by word of mouth from father to son.

The story of how farming advanced from this stage to a highly technical science is essentially the history of the University of Illinois College of Agriculture.

It was a desire to improve agricultural and mechanical knowledge that led to the establishment of the University on March 2, 1868. This was made possible by the passage of the Morrill Land-Grant Act of 1862, which allowed the sale of public land for the funding of colleges to teach "agriculture and the mechanic arts."

Two unexpected problems arose in the early years and had such serious effects on the young college that by 1895 the College of Agriculture was considered a failure, although the University as a whole was flourishing.

One problem was simply that agricultural science did not exist then. A third of a century passed before the early agricultural researchers developed principles that are the basis for today's broad field of agricultural science.

The second major problem became evident around 1895 — it was nearly impossible for the College to attract students because it had almost no physical facilities. For example, in 1895 only seven of the University's 800 students were enrolled in agriculture, taking one 10-week course. That course was taught in the basement of another college's building. The College had three faculty members and a yearly budget of $5,000, excluding Experiment Station funds.

How the College overcame these early problems and became one of the world's outstanding colleges of agriculture is briefly described in the following discussion of the four areas of work into which the College is now divided. These are research, student instruction, Cooperative Extension, and international programs.

Research

The enormous value of agricultural research in the College has been dramatically illustrated by a national magazine which pointed out that as a result of the University's research, the farmers of Illinois are making more money every year than the state has spent on the entire University since it was founded in 1868.

Some elementary experiments were begun in the early years of the College, but a serious lack of funds impeded research until 1888. That year, the Illinois Agricultural Experiment Station was established in accordance with the Hatch Act of 1887. Under the terms of the act, each state received $15,000 a year to support agricultural experiment stations.

During its first year the Experiment Station used its $15.000 budget for 100 experiments in field crops, cattle feeding, dairying, and horticulture. These early projects dealt with problems that farmers wanted solved as soon as possible. Thus the Experiment Station immediately commanded the farmers' respect in a way that the College as a whole was not able to do for some years to come.

Since 1888 the Experiment Station has continued to expand its scope. There are now about 360 active projects. The annual budget is over $6 million, consisting of federal, state, and private funds.

Following are a few examples of the research that has been conducted through the College's history, even before the establishment of the Experiment Station:

- The Morrow Plots, America's oldest experiment field, were established in 1876.
- In 1878 Thomas J. Burrill presented the first proof that bacteria can cause plant diseases.
- The concept of permanent soil fertility was developed at Illinois.
- The College promoted the production of soybeans and developed markets for them in the 1920's.
- Farm business record studies have greatly improved farm management.

Paul W. Rexroat is Assistant Publications Editor, College of Agriculture.

• Illinois agricultural engineers led development of rural electrification and farm mechanization.

• Illinois developed cleaned-in-place pipeline milking systems and direct milking into refrigerated tanks.

• The relationship between diet and heart disease is now being studied.

Student instruction

The College, with it seven students, three faculty members, and $5,000 budget, was almost nonexistent when Eugene Davenport, a brilliant administrator, was named dean in 1895.

Dean Davenport's first goals were to increase the College budget so more teachers could be hired; to obtain a building to house students; to "set out a dragnet" for students; and to get more research funds.

By 1905 the budget for teaching and research had increased to $91,000, the College and Experiment Station faculty had grown to 44, the building now known as Davenport Hall was constructed at a cost of $165,000, and 430 students were enrolled in agriculture.

Today there are 2,100 graduate and undergraduate students and 890 full-time staff members in teaching, research, and extension. The budget for instruction alone is $2,100,000.

More than 15,000 degrees have been awarded in agriculture. These include about 12,100 B.S. degrees, 2,200 M.S. degrees, and 770 Ph.D. degrees.

The College now offers about 180 undergraduate and 90 graduate courses in the following areas: agricultural communications, agricultural economics, agricultural engineering, agronomy, animal science, dairy science, food science, forestry, home economics, horticulture, and plant pathology.

In addition to academic training, students receive experience in leadership and responsibility by participating in various student organizations on campus.

The average graduate from the College in June of 1967 received about $7,050 as a starting salary.

Cooperative Extension

Extension-type education began in Illinois as early as 1870, when members of the College staff started giving off-campus lectures.

Passage of the Smith-Lever Act 44 years later (1914) established the Cooperative Extension Service. The act eventually led to the appointment of farm and home advisers in nearly every county in the state. This provided the framework for large-scale cooperation between the College of Agriculture and Illinois farmers.

The development of local leadership has been a constant goal of the extension service. The 4-H club and home economics programs make extensive use of local club leaders.

The following is a brief discussion of the areas in which extension workers have made outstanding contributions in Illinois.

• **Soils and crops.** Extension work was a major force in helping Illinois farmers outdistance all others in soil fertility. Extension workers urged adoption of improved cultivation practices, seed varieties, and farm machinery.

• **Livestock.** The breeding, feeding, and management of livestock has been a key area of extension work in the state. Special programs have been developed for all types of livestock.

• **Youth work.** Illinois has long had educational clubs for boys and girls. The first was a corn club formed in 1899. There are now 4,000 4-H clubs with 82,000 members in the state.

• **Family living.** Home economics specialists and home advisers have worked since the 1930's to help local women make family living more satisfying.

Today extension programs are being adjusted to meet the needs of more social, economic, and occupational groups.

International programs

The College of Agriculture first participated in international agricultural programs in 1918 when Cyril G. Hopkins went to Greece to help improve production of food grains.

Formal College participation in international programs began in 1952 under a contract with the Technical Cooperation Administration (now called the Agency for International Development) for work at the Allahabad Agricultural Institute in India. Nine College faculty members were employed during the first contract.

Today the College has about two dozen faculty members serving under contracts with the governments of India and of Sierra Leone in Africa. The goal is to help set up schools that will serve agriculture there as well as the University of Illinois has served Illinois agriculture.

The agricultural campus as it appears today.

Historic Costumes Enhance Our Understanding of the Past

LORRAINE TREBILCOCK

THE CELEBRATION of a Centennial focuses attention on the past. Old photographs are studied, old records searched, the oldest alumni interviewed, as people pause to reflect on life in the "good old days."

Many reminders of the past may be found in a collection of clothing, accessories, and magazines belonging to the Department of Home Economics and housed in Bevier Hall. The collection includes such items as a white fichu, or scarf, dating from the days of the French Revolution; a parasol with a handle that could be folded to avoid jabbing the other occupants of a buggy; a "duster" worn over good clothing when one ventured out in a horseless carriage, braving the dust which would be raised in the swift 15-mile-an-hour ride on unpaved roads.

Everything in the collection has been donated by individuals interested in the work of the department. Many of the items have close association with the history of the University, as for example, a white organdy dress with elaborate bustle and train that looks much like today's idea of a wedding dress. This garment was worn by Miss Nettie Adams of Urbana when she was graduated from the University in 1877. Miss Adams was one of 12 women in a class of 41.

The primary purpose of assembling and storing the collection is for use in teaching and research. Textile classes, for example, have an opportunity to see and handle garments made of fibers and fabrics now disappearing from the market, such as the whole gamut of silk — chiffon, georgette, canton, tussah, pongee.

Clothing selection classes become aware of the particular taste of each period. In an era of dressing when "less is more," students are enthralled by the lavish compounding of fabrics and trims. One dress, for example, is made of an elaborate black lace draped over eggshell satin, encrusted with black sequins and appliqued flowers.

Clothing design and construction classes have an opportunity to gain inspiration from the collection, just as Paris designers study at the Cluny Museum, and New York designers delve into the Costume Institute of the Metropolitan. Interested in the pagoda sleeves of the Civil War period, the pouter pigeon look of 1905, the slinky bias cut of the 1930's? They are all here, to be studied, adapted, constructed.

Students of historic costume profit from seeing the actual costumes they have been reading about and have been seeing on slides in the classroom. Showings are arranged, with key costumes being modeled by class members. If, as some people say, a picture is worth 10,000 words, then the value of seeing the real thing cannot be measured. To the student's exclamation of "I can't believe people really wore these things," it is possible to say, "Here they are; see for yourself."

Small displays are often set up in Bevier Hall, to be enjoyed by students and visitors. There have been two major displays in recent years. During a Farm and Home Show in the early 1960's, 20 wedding gowns, ranging in dates from 1830 through 1960, were shown on mannequins. This exhibit gave viewers an excellent opportunity to admire the elegant fabrics, intricate design, and exquisite workmanship.

A more recent exhibit was set up in connection with the 1967 Festival of Contemporary Arts. As part of the festival, the Department of Home Economics displayed weaving, stitchery, and quilting by skilled contemporary craftsmen. In keeping with the University Centennial, an adjoining room was set up to show work by craftsmen of another era. All items in this display were from the department's collection, and all had been done in the home. It was apparent from the beautiful assortment of Battenberg lace, Teneriffe drawnwork, Italian hemstitching, Irish crochet, embroidery, knitting, quilting, and weaving that the craftsmen of the past possessed excellent design sense and were highly skilled. Many visitors at the exhibit gained pleasure from noting how the contemporary craftsmen had adapted the techniques of an earlier time to express life as it is today.

From time to time, the collection is shown to groups if the purpose of the showing is educational rather than merely entertaining. One of the most responsive groups was made up of 20 bright, attentive third graders from the J. W. Hays School in Urbana. Since the class was studying a unit on clothing, the teacher thought it would be profitable for them to see some clothing of the past. Items selected for this program included a money pocket from 1766, a calash (folding bonnet) from 1798, a fan made from the feathers of all the species of wild birds in South America, and a dress worn by an eight-year-old boy in 1875.

A few days after the visit, the children sent charming letters of thanks. One said, "I think you taught me a lot. The clothes were very pretty especially those dresses on the forms. I think if I see another exhibit about old clothing yours would be the best."

Lorraine Trebilcock is Professor of Textiles and Clothing.

Five Costumes From the Collection

1810. The neo-classic Empire silhouette expresses the feeling of the period following the French Revolution. The lavish ways of the pre-1789 court had died with Marie Antoinette. Gone were the silks, panniers, and skirts that swept the floor. Inspired by the graceful lines of the Greek chiton, women donned simple dresses, hand-made from the sheerest of cottons. Lacking even such decorative yet functional items as buttons, this garment fastens by means of drawstrings.

1845. By the mid-1840's, elegance was once again in vogue. This dress, made of yards and yards of stiff silk fabric, illustrates the trend toward tight lacing at the waist and wide skirts.

1860. The crinoline skirt, worn over six petticoats, and the modest, covered look characterize the costume of the Civil War period. This beautiful blue silk dress, with pagoda sleeves, was worn by an Urbana resident when she visited the Lincolns in the White House.

1870. The bustle had arrived as fashion decreed that skirt fullness be pushed to the back. The puffs, swags, ribbons, and laces epitomize Victorian fussiness.

1890. This costume, with its leg-of-mutton sleeves and floor-sweeping skirt, was part of one young lady's wardrobe when she entered the University of Illinois in the 1890's. Women were beginning to discard some of the cumbersome clothing of the past, and fullness had moved to the shoulder area, where it did not interfere with the work of the stenographer, the switchboard operator, or the school teacher.

1810. *Model: Judy Richardson*

1845. *Model: Eileen Frank*

1860. *Model: Janet Izard*

1870. *Model: Eileen Frank*

1890. *Model: Elizabeth Del Bocce*

ASCORBIC ACID CONTENT OF FRUIT JUICES AND DRINKS

Orange and grapefruit juices remain the most reliable sources of vitamin C in recent tests

AIKO PERRY, SHU-HWA REI, KUO-HOWERE YU, and FRANCES VAN DUYNE

Oranges and other citrus fruits have long been known to be good, reliable sources of vitamin C or ascorbic acid. For years many persons have depended on a daily glass of orange juice for a good share of their vitamin C requirements.

Although ascorbic acid is more likely than other vitamins to be lost or destroyed during processing, it is relatively stable in citrus products. Numerous studies have shown that orange juice retains a large percentage of ascorbic acid after canning, freezing, or several days of refrigerator storage.

One year-long study was made in the food research laboratory some time ago. Fresh juices from California and Florida oranges were compared with two frozen concentrates, a canned concentrate, and seven canned juices. Freshly prepared California orange juice had the highest ascorbic acid content — 51 milligrams per 100 grams of juice. Mean values of the other products ranged from 39 to 42 milligrams per 100 grams.

Products studied

Recently many new juices and drinks have appeared on the market. They provide variety in flavor, but how do they compare with orange juice in vitamin C content and in vitamin C retention during storage?

We particularly wanted some answers as part of a study on the nutrient intake of nursery school children. Since the published literature did not contain the needed information, we had to seek our answers in the laboratory. Accordingly we determined ascorbic acid values for nine frozen fruit juices and punches.

Each product was bought two or three times at a local market. Until the products were tested, which was anytime from one day to one week after purchase, they were stored in a freezer at about $-25°$ C.

Products were reconstituted according to directions on the cans except that distilled water was used instead of tap water. After samples of the freshly reconstituted drinks were taken for ascorbic acid determinations, the remaining portions were put into covered glass containers and stored in a refrigerator at about 6° C. for a week. Further analyses were then made on the stored samples. Reduced ascorbic acid was determined on all samples by a chemical method which prevents the pigments in the products from distorting the results.

Reduced ascorbic acid can be oxidized to dehydroascorbic acid, and then to diketogulonic acid. Dehydroascorbic acid is biologically active (capable of being utilized by the body), while diketogulonic acid is not. Together, dehydroascorbic acid and reduced ascorbic acid make up total ascorbic acid.

To find out if more biologically active vitamin C was present than the analyses for reduced ascorbic acid indicated, we determined total ascorbic acid for three of the products — frozen concentrated banana-orange, grape, and orange juices.

Table 1. — Reduced Ascorbic Acid in Reconstituted Juices and Punches

Product	Reduced ascorbic acid content[a]		Ascorbic acid retention
	Freshly reconstituted	1 week in refrigerator	
	mg./100 gm.	mg./100 gm.	percent
Banana-orange juice	23.6 ± 1.31	19.9 ± 2.75	84
Grape juice	14.6 ± 0.18	4.1 ± 0.09	28
Grape-lemon punch	3.3 ± 0.23	1.5 ± 0.28	46
Hawaiian punch	2.6 ± 0.15	0.6 ± 0.35	25
Lemonade	5.2 ± 0.18	0.8 ± 0.17	16
Orange juice	38.2 ± 2.10	33.2 ± 1.73	87
Pineapple juice	9.1 ± 0.16	3.8 ± 0.38	42
Raspberry-lemon punch	5.7 ± 0.36	1.2 ± 0.62	21
Strawberry-lemon punch	6.1 ± 0.15	1.2 ± 0.36	21

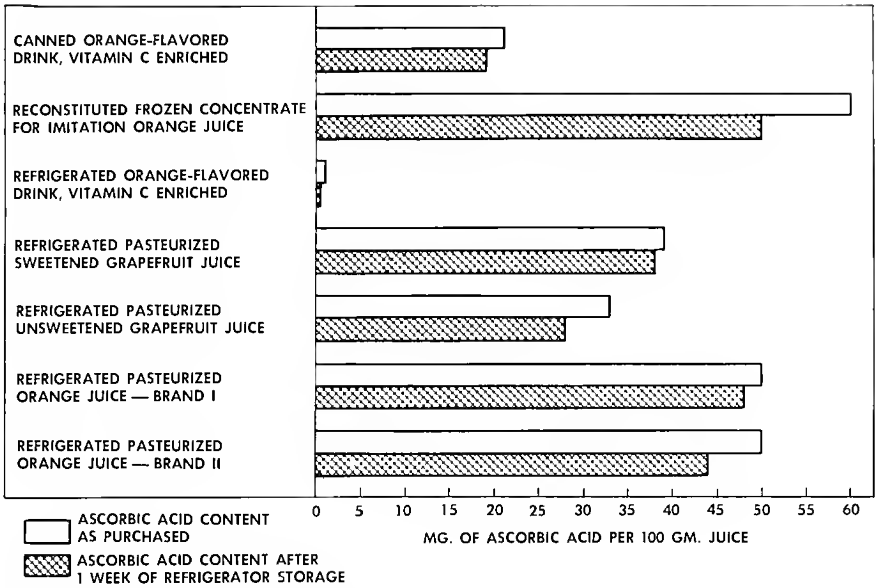
[a] Mean values for 2 or 3 replications and standard deviations of the means.

Table 2. — Reduced and Total Ascorbic Acid in Reconstituted Juices[a]

Product and form of ascorbic acid determined	Ascorbic acid content[b]		Ascorbic acid retention
	Freshly reconstituted	1 week in refrigerator	
	mg./100 gm.	mg./100 gm.	percent
Banana-orange juice			
Reduced ascorbic acid	30.7 ± 0.18	25.8 ± 0.39	84
Total ascorbic acid	31.6 ± 0.41	27.2 ± 0.54	86
Grape juice			
Reduced ascorbic acid	15.9 ± 0.42	6.3 ± 0.16	39
Total ascorbic acid	16.2 ± 0.77	8.0 ± 0.43	50
Orange juice			
Reduced ascorbic acid	36.6 ± 0.74	29.8 ± 1.00	82
Total ascorbic acid	38.1 ± 0.47	33.2 ± 1.23	87

[a] Total ascorbic acid is equal to the amounts of reduced and dehydroascorbic acids.
[b] Mean values for 4 replications and standard deviations of the means.

Aiko Perry is Instructor in Foods; Shu-Hwa Rei was formerly Assistant in Home Economics; Kuo-Howere Yu is now Assistant; Frances Van Duyne is Professor of Foods.



Effect of refrigerator storage on ascorbic acid content (mean values for 5 replications of refrigerated orange-flavored drink and 4 replications of the other products).

Additional samples of the three products were purchased and four replications of each were analyzed for total and reduced ascorbic acid.

Some time later a second group of products was studied. It included six kinds of drinks: a canned orange-flavored drink enriched with vitamin C, a frozen concentrate for imitation orange juice, a refrigerated orange-flavored drink enriched with vitamin C, sweetened and unsweetened refrigerated pasteurized grapefruit juice, and refrigerated pasteurized orange juice (two brands). Four samples of each were analyzed for reduced ascorbic acid before and after a week of storage in the refrigerator. The method of analysis was that usually employed in the food research laboratory.

How the nine products compared

Table 1 gives mean values for the reduced ascorbic acid contents of the first nine products studied. As expected, the reconstituted frozen orange juice concentrate was highest in ascorbic acid, while Hawaiian punch was very low. The banana-orange juice appeared to be a good source of vitamin C.

For three of the freshly reconstituted products, the values in Table 1 are somewhat lower than those given in the 1963 revision of Agriculture Handbook No. 8, "Composition of Foods — Raw, Processed, Prepared." In this handbook, the ascorbic acid contents given for diluted frozen lemonade, orange juice, and pineapple juice are, respectively, 7, 45, and 12 milligrams per 100 grams. On the other hand, the handbook gives a lower value for grape juice — 4 milligrams per 100 grams — than we found. However, the product we analyzed contained added vitamin C.

After a week of refrigerator storage, orange juice and banana-orange juice were the only two products that retained most of their ascorbic acid and even they lost measurable amounts (Table 1).

Mean values for the reduced and total ascorbic acid contents of additional samples purchased several months later are shown in Table 2. Grape juice and orange juice had about the same ascorbic acid contents as before, but banana-orange juice had appreciably more.

All samples contained small amounts of dehydroascorbic acid, so that mean values for total ascorbic acid were slightly higher than those for reduced ascorbic acid. During a week of storage, dehydroascorbic acid contents increased slightly. These increases, however, accounted for only a small part of the losses in reduced ascorbic acid during storage. It can therefore be assumed that refrigerator storage reduced biological activity.

Comparison of the six products

Mean values for the reduced ascorbic acid content of the second six products are depicted in the graph. Amounts varied from less than 1 milligram per 100 grams of a refrigerated orange-flavored drink to 60 milligrams per 100 grams of a reconstituted frozen concentrate for imitation orange juice. The refrigerated pasteurized orange juices appeared to be excellent sources of vitamin C, and the refrigerated pasteurized grapefruit juices, good ones. Canned orange-flavored drink enriched with vitamin C was a fair source.

After a week of refrigerator storage the retention of vitamin C ranged from 83 percent for unsweetened grapefruit juice to 95 percent for one brand of refrigerated pasteurized orange juice. Although the imitation orange juice lost 16 percent of its initial ascorbic acid during storage, it still retained more ascorbic acid than the other products did.

How well juices meet requirements

The Recommended Daily Dietary Allowances for ascorbic acid range from 40 milligrams a day for children to 80 milligrams a day for boys 12 to 18 years old and for girls 9 to 15. Adult allowances are set at 70 milligrams a day.

In this article, ascorbic acid contents have been given in milligrams per 100 grams of juice. One hundred grams equals about 3.5 ounces, which is the capacity of many juice glasses. Therefore it can be seen from the tables and graph how much vitamin C the different drinks can contribute to your daily intake.

In general, the results confirm the value of orange and grapefruit juices processed in different ways, while indicating that fruit-flavored punches and drinks (even considering that more than twice as much may be consumed) are less reliable sources of vitamin C.

THE DIAGNOSTIC-RESEARCH LABORATORY

Where diagnosis of animal diseases, serological tests, and veterinary research are all in a day's work

J. A. YOUNGREN

SERVICE to the livestock and poultry industry is combined with research at the Diagnostic-Research Laboratory in Urbana. The laboratory is maintained at the College of Veterinary Medicine by the Division of Meat, Poultry, and Livestock Inspection of the Illinois State Department of Agriculture.

The work of the laboratory may be divided into three main categories: diagnosis of animal diseases, serological testing for regulatory activities, and applied research. Regional or branch laboratories at Centralia and Peoria share the work of diagnosis.

Most of the specimens that come into the laboratory for diagnosis are referrals from practicing veterinarians. Results of postmortem examinations on poultry are sent to the owners and to servicemen, but all reports on mammalian species are sent to the referring veterinarian. He is able to interpret the often technical reports and to take the steps necessary for speedy control of the problem.

The Diagnostic-Research Laboratory is in a position to study the incidence of animal diseases in Illinois and to spot disease problems of interest to agriculture. Of special concern are the diseases that may be brought into Illinois from other areas.

In postmortem examinations of animals, the diagnostic section collects specimens which are referred to the College of Veterinary Medicine laboratories for the special tests that are required to make differential diagnoses. With this cooperative arrangement, the College of Veterinary Medicine obtains material for teaching and basic research, and the Division of Meat, Poultry, and Livestock Inspection can evaluate disease problems affecting both animal and human health.

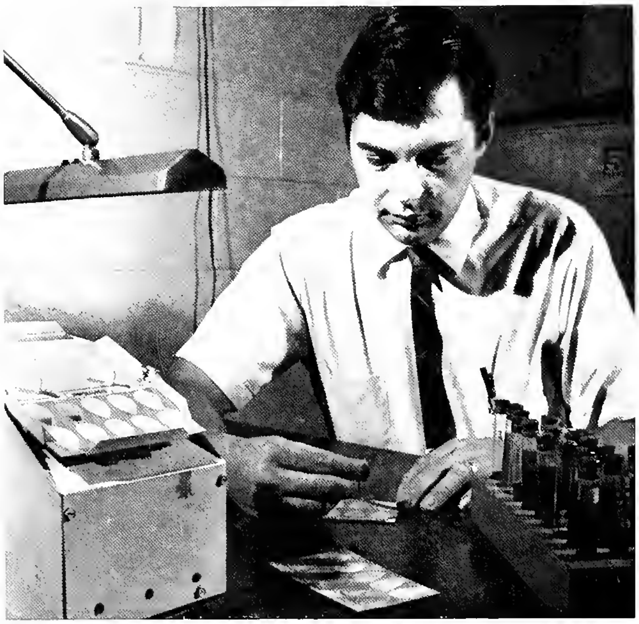
Rabies receives much attention

Rabies diagnosis is one of the main activities in the Diagnostic-Research Laboratory. The incidence and distribution of rabies in Illinois has been recorded and compiled over the years, allowing epidemiological studies of the disease.

At present there has been a sizable decrease in rabies of domestic animals. This is probably the result of

J. A. Youngren is a veterinary pathologist on the staff of the Diagnostic-Research Laboratory.

Brain tissue is being removed from a cat in preparation for the fluorescent antibody rabies test. This relatively new test has facilitated rabies diagnoses.



Using the card test for brucellosis, Dr. Youngren adds blood serum to antigen preparations on the cards, to determine whether the blood contains antibodies to the pathogen.

controlling stray dogs and of mandatory rabies vaccinations. In 1965 there was an increase in rabies in cats, but subsequent control measures have reduced the problem.

The increase in cat rabies was associated with skunk rabies, since both species have nocturnal habits. Skunk rabies has been increasing over the past 10 years and is the primary reservoir of the disease.

The diagnosis of rabies has been expedited in recent years by a relatively new procedure known as the fluorescent antibody (F. A.) test. Antibodies to rabies virus are prepared by injecting the killed virus into horses, and are then purified and labeled with a fluorescein dye. When combined with brain tissue, the labeled antibody couples with any virus particles that are present in the tissue. The test is then read with an ultra-violet microscope.

For several years staff members of the Urbana laboratory have compared the F. A. test with the older method of diagnosis (detection of Negri bodies on stained smears and mouse inoculation). The F. A. test has been found to be not only very rapid, but also just as accurate as the older test.

Swine diseases

The Diagnostic-Research Laboratory has long cooperated with the College of Veterinary Medicine in studying the swine diseases that cause the greatest economic loss to Illinois hog producers. Expansion of the program was made possible in 1963, when the Illinois legislature appropriated $80,000 for the study of TGE and other swine diseases.

As part of the State-Federal Hog Cholera Eradication Program, many hog cholera suspects are submitted to the laboratory for a rapid diagnosis. The program includes other control measures as well — more stringent regulations on movements of feeder swine, cooking of garbage fed to swine, and proper use of the modified live hog cholera vaccine. As a result, the incidence of the disease has markedly decreased. There were 181 cases in 1963, 105 in 1964, 63 in 1965, and 46 in 1966.

This year the Division of Meat, Poultry, and Livestock Inspection initiated a "disease of the year" study. The disease receiving special attention in 1967 is swine brucellosis. Included in the program are supplemental brucellosis tests and bacteriological studies at the time of slaughter. The purpose is to determine the actual prevalence of the disease and to eradicate swine brucellosis in reservoir herds. A reservoir herd is one in which the infection exists and is disseminated without causing an apparent clinical problem.

Cattle diseases

The work on cattle diseases has been primarily of a diagnostic nature. The College of Veterinary Medicine has conducted serological examinations for infectious bovine rhinotracheitis (IBR) and bovine virus diarrhea (BVD), which seem to be the most important viral diseases of cattle.

Work is continuing to eradicate bovine brucellosis, which has already been reduced to a very low level. The 8-minute plate test and tube tests are still used in a routine manner. However, new and more specific tests for brucella antibodies have been added to study and eradicate brucellosis in problem herds where the older routine tests have not been satisfactory.

Other studies are yielding new information about leptospirosis of both cattle and swine. The primary pathogen is *Leptospira pomona*, but other strains have been found important in studies of the agents causing abortion in these two species. Herds have been found with problems due to *L. hardjo* and *L. grippotyphosa* as well as *L. pomona*.

Equine diseases

The importance of equine diseases has grown because of the great increase in pleasure horses. At present there are about 6 million horses in the United States. This figure is expected to double in the next 10 years. In 1964, the estimated horse population in Illinois was 200,000.

In 1966 a new program of horse inoculation was begun for diagnosis of equine infectious anemia. A suspected increase in this disease had been causing concern among veterinarians and the Illinois Racing Board, since a considerable tax contribution comes from parimutuel betting at Illinois racing tracks. In past years, race tracks in other states have had to be quarantined because of equine infectious anemia.

Investigation showed that there was indeed an appreciable increase of the disease in this state. As of July 1, 1966, there were 38 confirmed cases. Since many race horses are transported throughout the United States, it became desirable to have facilities for substantiating the diagnosis of equine infectious anemia and controlling the movement of infected horses. A testing station was therefore established at Lincoln for horse inoculation, which at present is the only reliable diagnostic technique. A diagnostic school will be held in October, 1967, to train federal and state veterinarians in procedures for diagnosing this ill-defined disease.

Since there are no reliable serological tests, research is being conducted to develop a rapid and reliable test. Research materials are collected from experimental and clinical cases.

The incidence of equine viral encephalitis decreased considerably in 1966. In 1964 there were 263 confirmed cases; in 1965, 155 cases; and in 1966, 61 cases. Since this disease is transmissible to man, it is very important to establish the sources of infection, means of spread, and subsequent control. For this purpose, rapid diagnoses must be made and the incidence studied in various areas.

Rapid, accurate diagnoses are, in fact, necessary in the control of every animal disease. The primary concern of the laboratory is to speed up diagnoses and to integrate specimens into research programs as they are needed.

Oxytocin in Blood of Cows During Milking

The hormone oxytocin, necessary for release of milk, declines rapidly after udder is washed

R. L. HAYS and D. E. PRITCHARD

Before a cow can be milked, her pituitary gland has to release a hormone called oxytocin. Although we know that this hormone is essential for milk removal and consequently lactation, we know very little about the exact amounts of oxytocin that are necessary.

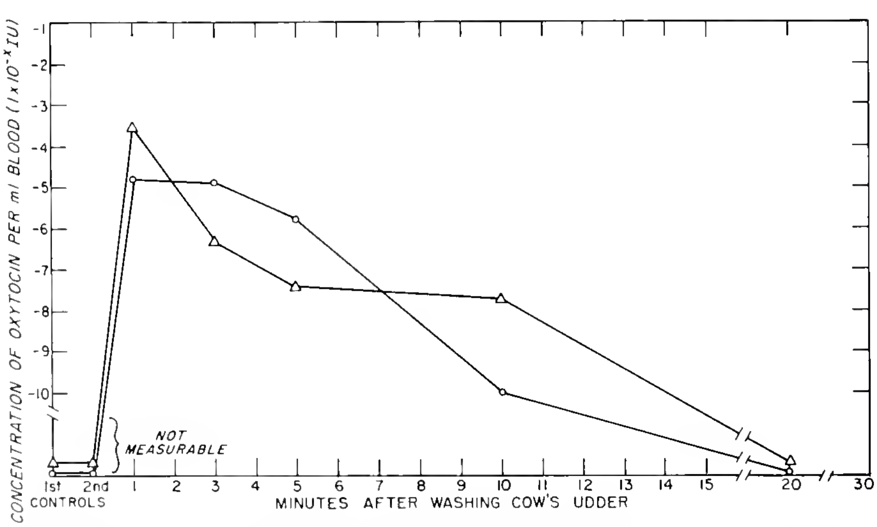
The meagerness of our knowledge is partly due to the fact that the amounts of oxytocin in the blood are very minute. Most assay procedures are not sensitive enough to determine these small amounts without relatively laborious extraction techniques and expensive equipment. Other difficulties are intrinsic within the assay procedures.

As a consequence of all these problems, the results of measuring oxytocin have been questionable and varied. In a 1964 study by Folley and Knaggs, for example, 5 of 14 blood samples taken during milking contained no measurable oxytocin, and the oxytocin content of the other 9 samples ranged from 17 to 2,000 microunits per milliliter.

Since the introduction of a new bio-assay by van Dongen and Hays in 1964, the measurement of oxytocic activity in blood plasma is now relatively simple. Using this method, we studied the amounts of oxytocin in the blood plasma of five cows during milking. A Guernsey, a Jersey, a Holstein, and two Brown Swiss producing 35 to 41 pounds of milk a day were used.

Obtaining blood samples

Blood samples were taken from the jugular vein of each cow during two to four milkings. To avoid frightening the cows with a needle and hence inhibiting milk ejection, we obtained the samples by means of an indwelling polyethylene tube (2 millimeters in diameter). Each 10-milliliter sample was withdrawn in a plastic syringe in 10 to 15 seconds. It was then placed in a cooled plastic centrifuge tube containing 0.1 c.c. of 300 USP units of heparin per milliliter of saline. The centrifuge tubes were stored in an ice chest at 0° C. for 20 minutes. They were then centrifuged at 1350 r.p.m. in a room held at 15° C. After centrifugation the plasma from each sample was withdrawn with a plastic syringe and put in a plastic vial which was capped and stored at −18° C.



Level of oxytocic activity in the blood of Cow 1 after milk ejection. Two of the other cows normally showed a similar rapid decline in oxytocin. (Fig. 1)

Assay procedure

The assay is based on the time required for blood plasma or a solution containing known amounts of oxytocin to cause milk ejection in a piece of lactating rat mammary gland. The mammary tissue was taken from rats that had been lactating 7 to 15 days and that had been separated from their litters of at least seven young for 3 to 7 hours.

Lobes of tissue were placed in Tyrode's solution at 15° C. and were cut into pieces of about 6 cubic millimeters with microscissors. In a room at 15° C. a piece of tissue was placed in a drop of plasma or a solution containing a known amount of oxytocin. The tissue was observed with a 15X microscope and the time required for the tissue to eject milk was recorded with a stopwatch.

The relationship between log time and log oxytocin concentration is a

R. L. Hays is Professor of Physiology, Department of Dairy Science, and D. E. Pritchard was formerly an Assistant in Dairy Science.

straight line, with time decreasing as the oxytocin concentration increases. Using the solutions containing known amounts of oxytocin, we determined a standard straight line. The amount of oxytocin in the plasma was measured by making 10 to 15 determinations on each plasma sample and plotting the average time on the standard line.

A rapid decline in oxytocin

The highest concentrations of oxytocin were usually found in the sample taken 1 minute after the udder was washed. The oxytocin at this time averaged 0.0001 international unit (1×10^{-4} IU), or 0.0000002 milligram, per milliliter of plasma during the 14 milkings of the five cows.

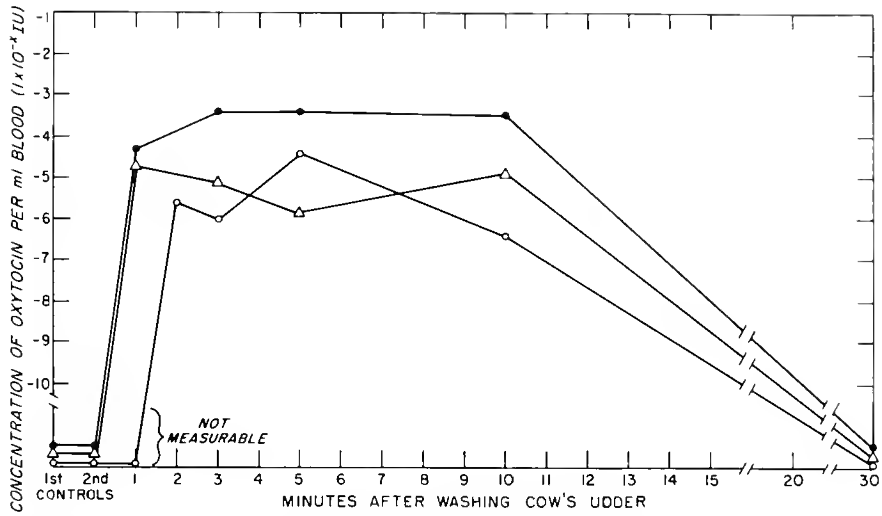
One half of the oxytocin disappeared each 0.3 to 1.2 minutes. This rapid decline is due to destruction or excretion in the kidney and liver and destruction in the lactating udder and pregnant uterus.

In all samples taken more than 10 minutes after washing the udder, the amount of oxytocin was too small to be detected. This emphasizes and explains the well-known fact that if milking is not completed shortly after milk has been ejected, some of the milk which should have been obtained is left in the udder. If this occurs consistently, the cow declines in production faster than normal and dries up sooner than she would have under a normal milking routine.

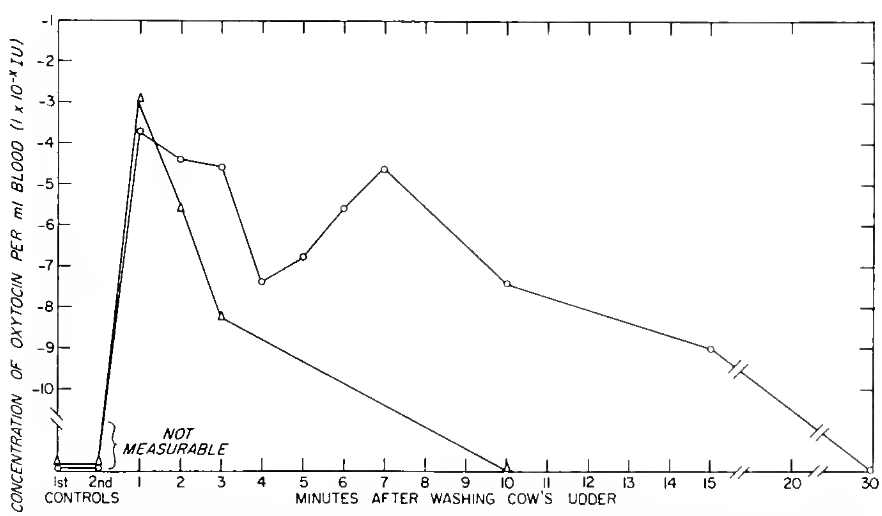
The decline in oxytocin was faster in three of the cows (Fig. 1) than in the other two (Fig. 2). The two cows with the slower decline were the Brown Swiss. It may have been coincidence, but these two cows required 6 to 7 minutes to milk out, while the other three were completely milked out in 4 minutes or less. The reason for the differences in the decline of oxytocin is not known, but these variations do emphasize the point that cows differ in their physiological reactions to milking.

An unusual type of oxytocin disappearance curve is shown in Figure 3. At one milking, the curve was normal. At the other milking, the stimulus of washing the udder caused oxytocin to be released into the blood, but the milking machine was not put on until 4 minutes later. Putting on the milking machine caused a second release of oxytocin, resulting in a second milk ejection. The oxytocin then declined in a normal manner.

The second ejection occasionally occurs when a cow is not milked right after the first ejection. Since one cannot depend on this happening, however, a routine which causes ejection too long before milking will usually reduce the amount of milk obtained.



Level of oxytocic activity in the blood of Cow 2, a Brown Swiss, declined more slowly after milk ejection than did the level in Cow 1. One other cow, also Brown Swiss, showed a relatively gradual decline. (Fig. 2)



Level of oxytocic activity in the blood of Cow 3. A double ejection occurred at one milking. Oxytocin declined normally after the second ejection. (Fig. 3)

More cows to be tested

Research in this area is continuing and larger numbers of cows will be tested for their release of oxytocin in response to the various stimuli of milking. Also under study is the relationship between oxytocin release and unusual conditions, such as the presence of strangers, which might upset the cow.

CHEMICAL ANALYSIS OF CORN LEAVES

Used in conjunction with soil tests, plant analysis shows promise as a valuable tool for measuring soil fertility and predicting crop yields

W. M. WALKER and T. R. PECK

Dr. Peck with the emission spectrograph, the instrument used to analyze plant samples.

EARLY in the history of agricultural science, chemists ashed plants in an attempt to relate a plant's chemical composition to its requirements for growth and reproduction.

Today interest has been renewed in quantitatively relating the chemical composition of a plant or plant part to subsequent yield. Our research objectives have become somewhat more refined since the early days, however, and our analytical techniques have changed considerably. We now use electronic equipment which enables us to determine the nutrient status of the plant both rapidly and accurately.

Enough progress has been made that we have good reason to be optimistic about the potential usefulness of plant analyses in measuring soil fertility and predicting crop yields.

The value of plant analysis

Of the chemical elements that plants need for growth, all but three (carbon, hydrogen, and oxygen) are normally taken up by the plant from the soil. The mineral composition of the plant may therefore indicate the soil's nutrient status. This suggests a permanent relationship between plant analyses and soil tests as diagnostic tools in solving problems of plant nutrition and crop production. It is not supposed, however, that plant analyses can replace soil tests. Since soil tests can be made before planting, they remain a valuable forecaster of fertilizer needs.

Before we can fully utilize plant analyses as a diagnostic tool, we need to collect extensive data and make numerous calibrations between the plant's chemical composition, the results of soil tests, and yield.

Data are being collected on a number of crops. So far our most extensive work has been done with corn, since it is the most valuable economic crop in Illinois.

Samples from five fields

Leaf samples were taken from corn growing on three major soils — Muscatine, Sable, and Cisne — at five experiment fields. The average yields and range in yields at the five locations are shown in Table 1. Since these data were obtained from planned experiments, the wide range in yields can largely be explained in terms of soil fertility.

Corn leaf samples were taken from these plots during early tassel. The leaf beside and below the shoot — approximately the sixth leaf — was the one sampled. To minimize contamination, all samples were washed in the field as soon as they were picked. They were then dried, ground, and spectrographically analyzed at the University of Illinois Plant Analysis Laboratory.

Some relationships shown

Yields on the plots at each location were indexed as a percentage of the maximum obtained at the particular location. All plots were then divided into five groups on the basis of

Table 1. — Average Corn Yields and Range in Yield at Five Locations

Experiment field	Yield, bushels per acre		
	Aver.	Low	High
Aledo	120.8	40.3	149.2
Dixon	106.3	66.7	131.9
Kewonee	134.5	73.2	155.0
Oblong	98.0	49.0	129.6
Toledo	104.7	31.5	143.3

W. M. Walker is Assistant Professor of Biometry and Data Processing, Department of Agronomy; and T. R. Peck is Assistant Professor of Soil Chemistry Extension.

percentage yields. In Table 2 we see the average mineral composition of the leaf samples in each group, as well as soil test results and fertilizer treatment. Analysis of this table indicates some factors associated with high yields:

- High soil fertility as indicated by soil pH and by phosphorus and potassium soil tests.
- High levels of applied fertilizer.
- High leaf levels of nitrogen and potassium.
- Relatively moderate leaf levels of calcium, magnesium, manganese, and iron.
- Little direct association between yields and leaf levels of the individual elements, phosphorus, boron, zinc, and copper.

Although high yields are associated with high fertility, it is not possible to delineate from Table 2 the specific factors which would most economically or efficiently contribute to these yields. Preliminary statistical analyses suggest that a particular combination of some nutrients, both in the soil and in the plant, results in the maximum or near-maximum yields. An excess of a nutrient, as well as a deficiency, can lower yields.

The graph on this page illustrates the way in which the optimum level of one element is determined to some degree by the level of another element. At a leaf phosphorus level of 0.15 percent, for example, an increasing level of zinc in the leaf would decrease yields. If the leaf phosphorus level is 0.30 percent, varying the zinc concentration has little effect on yields. With a leaf phosphorus level of 0.40 percent, yields increase with an increasing level of zinc. The relationships shown in this graph are based on one year's work and may be modified as we collect and interpret more data.

Thus far we have found a relationship between yields and leaf levels of nitrogen and potassium that is similar to that found in other states. It suggests that high corn yields might be expected at leaf levels of about 3.0 percent for nitrogen and 1.8 percent for potassium, assuming that other nutrients are at an optimum level.

Table 2. — Average Yield, Mineral Composition of Leaf Samples, Soil Test Results, and N-P-K Treatment of Yield Groups

Item measured	Percent of maximum yield				
	95-100	80-90	70-80	50-70	Below 50
No. of plots	33	32	23	23	9
Aver. yield, bu./A.	140.4	123.8	109.1	77.4	50.3
Leaf composition					
Nitrogen, %	3.03	2.98	2.88	2.84	2.76
Phosphorus, %	0.24	0.26	0.25	0.23	0.26
Potassium, %	1.76	1.80	1.33	1.40	0.85
Calcium, %	0.51	0.50	0.56	0.51	0.60
Magnesium, %	0.34	0.39	0.48	0.43	0.51
Manganese, p.p.m.	47.0	55.0	65.0	86.0	98.0
Iron, p.p.m.	119.0	123.0	132.0	127.0	135.0
Boron, p.p.m.	14.2	15.1	14.4	15.1	15.0
Zinc, p.p.m.	29.8	31.8	31.0	30.0	26.0
Copper, p.p.m.	12.5	15.9	12.2	12.8	13.4
Soil tests and treatments					
pH	6.2	5.9	5.6	5.4	5.7
Avail. P, lb./A.	26	28	32	20	19
Avail. K, lb./A.	348	326	244	200	143
N applied, lb./A.	156	142	99	94	60
P applied, lb./A.	26	23	21	19	13
K applied, lb./A.	67	63	52	47	

Future plans

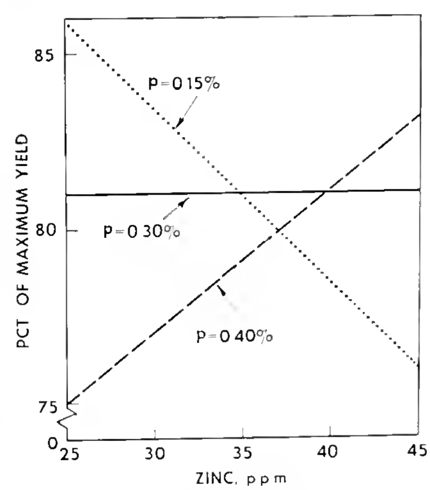
Eventually we hope to establish relationships between yields and the leaf level of every element required by the corn plant. As part of this objective, we want to determine the combination of nutrients necessary for highest yields. Once the desirable leaf levels of the nutrients have been established, we have the practical problem of how we can obtain these levels.

There are many other areas of important research in plant analysis. A best time to sample plants has not been established. It would be desirable, for example, to sample corn plants earlier than we have been doing, so that any necessary corrective measures could be taken in time to benefit the current crop.

The best functional relationship between crop yield and plant analysis needs to be determined. Results presented in this report are based on a particular mathematical model, but a better one may exist and, if it does, it may provide for more precise estimates of critical nutrient levels.

Variability from season to season needs to be measured and accounted for, and possible variability between varieties must be studied. A deficient nutrient level in one variety may be adequate in another. Soil concepts such as "nutrient mobility" need to be studied in relation to the chemical content of the plant or plant part.

Although we do not have ready answers for many of the questions raised about plant analyses, we believe that the answers we do have justify our confidence in the value of plant analysis as a diagnostic tool.



How corn yields vary with the levels of zinc and phosphorus in the leaf. The optimum level of one element is partly determined by the level of the other one.

FARM BUSINESS TRENDS

Of all the states, Illinois has the greatest interest in agricultural exports. Illinois is the leader in the production of both soybeans and corn, which are the principal farm exports for cash.

Exports of wheat exceed exports of corn and soybeans, but most of the wheat is shipped under foreign aid programs — not sold for cash.

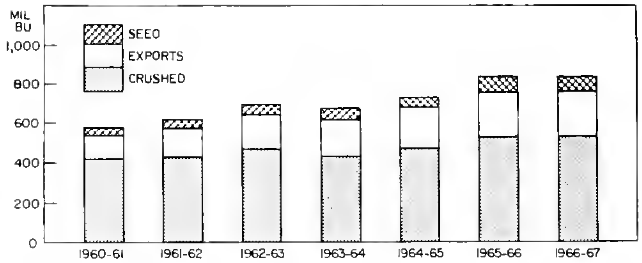
Over the past five years, Illinois farmers have produced 4,382 million bushels of corn, 3 percent more than any other state. They also produced 825 million bushels of soybeans, 25 percent more than the second-ranking state.

In 1966 Illinois farmers sold corn for $751 million, and soybeans for $474 million. These sales were for all purposes — domestic use as well as for export. Illinois farmers supplied 30 percent of all corn sold, and 19 percent of the soybeans.

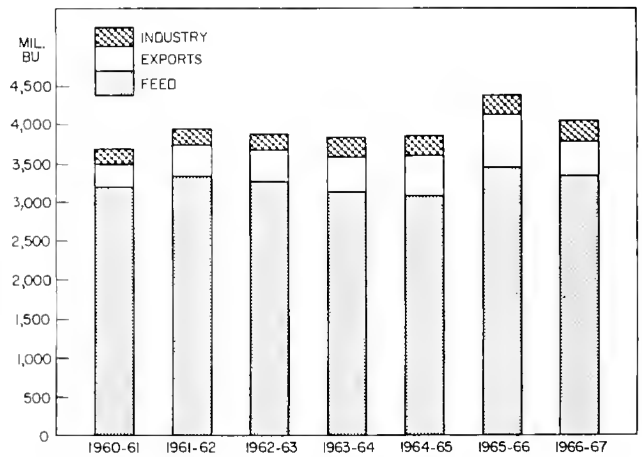
These two crops are now the nation's leading cash crops. According to USDA estimates, sales of corn brought U. S. farmers $2,536 million in 1966, and soybeans, $2,524 million. Cash receipts from sales of wheat totaled $2,025 million; cotton, $1,579 million; and tobacco, $1,211 million.

In the year ended with June, 1967, exports of soybeans from the United States were valued at $163 million. In addition exports of protein meal (mostly soybean meal) were valued at $241 million, and exports of vegetable oils (mostly soybean oil) were valued at $155 million.

During the same time exports of feed grains were worth $1,152 million. About $800 million of this amount was provided by corn.



SOYBEANS: Utilization in the United States, 1960-61 to 1966-67. This chart shows the amounts of soybeans crushed for oil and meal, exported, and used for seed during the past seven years. But in addition to the exports of beans, we also exported in 1966-67 about one-fifth of the oil and meal obtained from soybeans that were crushed in this country.



CORN: Utilization in the United States, 1960-61 to 1966-67. While most of the corn produced in the United States is fed to livestock and poultry here, exports have been trending upward. Exports were unusually large in 1965-66, when 670 million bushels were sold to foreign buyers.

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Winter, 1968

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

The Land-Grant university and world food needs

Malnutrition strikes hardest at children under five (page 6).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell......................Director

Margery E. Suhre....Editor, ILLINOIS RESEARCH

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OVERSEAS INVOLVEMENT OF U.S. UNIVERSITIES BEFORE WORLD WAR II

LONG BEFORE World War II, American agricultural scientists were working with scientists in many other countries.

Our plant breeders traveled far and wide seeking plant seeds that would be useful in breeding better crop varieties. Among the goals sought have been increased resistance to insects and diseases, resistance to drouth or frost damage, higher yields, fewer harvest losses, desirable processing characteristics, and better food values. In addition, plant explorers have searched faraway places for new plant species that might have economic value in the United States. Entomologists, too, have been international travelers seeking out parasitic insects that might control some of our domestic insect pests.

The U.S. livestock industry is based on importation of livestock breeds, largely from western Europe. For years animal breeders have continued to import animals that would improve our domestic lines.

Despite some exchange of ideas and materials, these international travels were undertaken with the motive of improving our own agriculture rather than exporting our agricultural know-how. Sometimes, it is true, staff members from Land-Grant institutions traveled abroad to study famine conditions in China and elsewhere. But usually observations led to the frustrating conclusion that the famine-ridden nation had no conceivable means of solving its own problems and that the United States did not have the food-producing capacities to meet their shortages.

The past 20 years have seen some complete reversals of our earlier attitudes. Not only are we shipping large quantities of food abroad, but we are dedicated to the proposition that the hungry countries can greatly increase their own food production. Land-Grant universities are committed to worldwide programs of technical assistance. Now the main concern of our international agricultural programs is to export the principles of agricultural research, teaching, and extension that have been so successful in this country.

(Some of the above remarks were excerpted from addresses by Dr. L. B. Howard and Dean O. G. Bentley. Other excerpts from their speeches appear on pages 18 and 22.)

One of the greatest problems facing us today is that of feeding the world's rapidly expanding population

The LAND-GRANT UNIVERSITY and WORLD FOOD NEEDS

The dimensions of the world food problem and the role of the Land-Grant universities in helping to meet it were explored at a symposium, "The Land-Grant University and World Food Needs," held on the campus last October. The College of Agriculture sponsored the symposium in observance of the Centennial year of the University of Illinois. Speakers included leaders from government, business, universities, and private foundations.

This issue of *Illinois Research* is devoted entirely to abstracts of speeches presented at the symposium. Complete texts of the speeches will be published in book form later this year.

Chancellor J. W. Peltason of the University of Illinois greets symposium visitors.

Professor Roger Revelle of Harvard University addresses the first session.

Even if population growth rates decline, world food production must be more than doubled during the next 20 years

Projected World Population and Food Production Potentials

ROGER REVELLE, Director, Center for Population Studies, Harvard University

A HUNDRED years ago, poverty was the common lot of most human beings everywhere in the world. Today we find two sets of nations staring at each other across the oceans, one rich and one poor, with a growing gap between them. The technological revolution has continuously improved the levels of living in the rich countries; in the poor ones its principal effect has been to multiply human misery by causing a greater rate of population growth than has ever before been experienced.

Man has lived on the earth for about a million years and during all but the last 1 percent of that time, birth rates and death rates must have been very nicely balanced. By 8,000 B.C. there were only about 5 million human beings. Then, with the invention of agriculture, a population explosion began which may have lasted two or three thousand years.

By the time of the birth of Christ there were perhaps 300 million people on the earth. Since no marked technical changes occurred during the next 16 or 17 centuries, human population grew very slowly until about 1650, when a second population explosion began.

From 1650 to about 1900 the rate of population growth was about 0.5 percent a year; from 1900 to 1950, nearly 1 percent a year. At present it is about 2 percent in the world as a whole and 2.5 to 3 percent in the poor countries. Now, instead of doubling in 20 or 30 thousand years, the earth's population doubles in about 30 years.

Such a short doubling time cannot continue for longer than a century or so. But this long-term view of a century or more is not something I want to discuss now, for it is essentially impossible to make predictions over that long a period. Instead, I want to confine myself to the next 20 years, about which it is possible to be quite specific.

The first thing we can say is that population growth and the lag in economic and social development in the poor countries are interrelated. Together they have created a specter that haunts these countries — whether there will be enough food in the future to feed their peoples. Obviously in the long run this specter will be exorcised only if population growth can be drastically slowed. For the next 20 years an unprecedented increase in world food supplies is equally necessary.

High infant mortality

Less developed countries are usually defined by their low per capita incomes. But they can be distinguished equally well by their high birth rates and high infant and child mortality. In these countries, with very few exceptions, up to 150 or even 200 children out of every 1,000 die before the age of one.

Parents want to be sure that one of their sons will grow to be a man, and they are willing to assume the burden of having too many children to gain this pathetic assurance. Many of these people say that they don't want more than four children, but they want four living children. Thus low child mortality may be necessary for reducing fertility.

If this is so, the quickest possible increase in the quantity and quality of food is of utmost urgency for the long term as well as for the short, for poor nutrition strikes most fiercely at the children.

In poor countries such as India and Pakistan, families at the bottom 25 percent in income level have a diet with energy and protein content less than 80 percent of the average for the population as a whole and 20 to 25 percent below nutritional requirements. Children in these low income groups exhibit clear clinical evidence of malnutrition.

How much food is needed?

Surprisingly enough, if there were a completely equitable distribution of food in the poor countries, the amount of food available would be just about enough for the populations. The people in these countries are much smaller than we are and so require less food.

This being so, we might say that all we need to do for the next 20 years is increase food supplies in proportion to population growth. This growth will probably be about 50 percent in the world as a whole, but will probably be greater in poor countries than in rich ones. In India, the population could be about 80 percent higher in 1985 than in 1965, or it could be less than 60 percent higher, depending on the effectiveness of birth control. In Pakistan the increase could range from about 82 percent to 108 percent.

But increasing the food supply just to keep pace with population growth is clearly not enough. One reason is that we have to greatly increase the average diet in the developing countries to make sure that the poorest people get enough to eat. Secondly, if the children eat enough they will grow bigger and their food requirements as adults will be larger than present requirements. Third, if we do slow the rate of population growth, the proportion of adults in the population will be larger and so food needs will be greater. Finally, agricultural development is completely impossible without overall economic development, and overall economic development will mean an increased demand for food.

If the economic development that is required for agricultural development is attained, food supplies in the poor countries will have to be increased by about 4 percent a year over the next 20 years, amounting to a total increase of about 120 percent.

How can food supply be increased?

One suggested way of meeting the need for food is to increase production in the United States and the other developed countries. At best, however, we could supply only about 10 percent of the poor countries' food needs by 1985.

Another possibility is to spread out on more land. Of 8 billion acres that possibly could be cultivated, only about 3 billion are now farmed. However, much of the land that isn't farmed is not very easily farmed. It would cost $500 to $1,000 an acre to bring this land under cultivation. A more serious problem is that the uncultivated land is unevenly distributed. Most of it is in South America and Africa. In Asia, which contains most of the world's hungry people, little arable land is left over.

What needs to be done is to increase the crops per year and the yields per crop, particularly in Asia. Irrigation development will be needed, plus other inputs such as fertilizer, improved crop varieties, pest control, and farm machinery.

Overall economic growth necessary

The farmer will have to buy these inputs and to do this he will need to make the transformation from traditional subsistence agriculture to market agriculture. The corollary is clear. Farmers will need customers who can afford to buy agricultural products, and these customers will exist only if there is general economic growth. Hence, agriculture cannot be developed in isolation, but only as part of the overall economy.

For supplies, agricultural production likewise depends on overall national production. Manufactured agricultural inputs, such as fertilizers, must be imported or produced domestically. If they are imported, the economy must generate sufficient exports or must have a net inflow of foreign assistance or investment. If they are to be produced domestically, the nonagricultural sectors of the economy must expand to meet the needs of agriculture.

Conversely, overall economic growth in most developing countries largely depends on agricultural growth. Many nonagricultural industries are based on agricultural raw materials. Most of the resources used for agriculture are not transferable to other types of production. For years to come, the majority of the people will continue to depend on farming for their livelihoods.

Rising farm incomes can bring dramatic improvements in rural employment. The transition from subsistence to commercial farming will produce a rapid expansion of supporting economic activities such as marketing, distribution, and packaging. As money incomes rise, small service industries and shops will begin to appear on the countryside.

As I said before, we can predict that, with rising incomes, food demand will increase by 120 percent over the next 20 years. This will mean a growth of 5.5 percent a year in the gross national product of the poor countries.

Knowledge is essential

Knowledge, as well as overall economic development, is necessary for agricultural development. The primary characteristic of modern market agriculture, as opposed to subsistence agriculture, is that it is a highly technical business based on scientific knowledge. This has come about very recently even in the rich countries. Only within the last 25 years have yields increased rapidly anywhere in the world.

The agricultural revolution in the United States since 1940 is one of the great events of history in terms of sheer scientific and technical accomplishment. With this fantastic success story, we have felt that we could simply apply our technology in the less developed countries. This concept, however, has proved to be a fallacy.

Research in the agricultural environment of the poor countries is quite essential for developing the knowledge necessary to increase yields. The work of agricultural specialists will not be enough. Sociologists, engineers, and humanists will be needed because the problems in the developing countries are very complex. These problems will not be solved in a year or 10 years; their solution will take two generations.

We must approach these problems not with short-term, quick-payoff programs as in the past, but with long-term, realistic, large-scale action. Poor countries cannot solve the problems by themselves. They will need extensive capital assistance, probably amounting to $5 billion a year, with about $1.5 billion of this for agricultural development.

Expanded technical assistance is absolutely necessary if we are to face any kind of a livable world 20 years from now. I would say that this will have to be provided by the cooperative efforts of the U.S. government, industry, the universities, and the great research laboratories.

Despite all that remains to be done, the present picture is by no means entirely dark. Already, for example, India and Pakistan have improved crop production. Our foreign aid effort has many good things about it, but there is too little of it and it is usually too late.

Every year malnutrition kills about 3 million children and inflicts permanent physical and psychological damage on countless others

NUTRITIONAL ASPECTS of the World's Food Needs

ARNOLD E. SCHAEFER, Chief, Nutrition Program, National Center for Chronic Disease Control, Public Health Service

NEARLY 2,000 years ago, Seneca warned the Roman Senate: "A hungry people listens not to reason nor is its demand turned aside by prayers."

In January, 1965, President Johnson, in his message to Congress, said: "The most grave health problem of the world remains hunger and malnutrition. We have long recognized that an insufficient food supply is a leading contributor to human misery and political instability. More recently, we have begun to recognize that it is also a major deterrent to economic and social development."

A look at per capita income indices tells us that 52 percent of the population of the developing countries exists on an average annual per capita income of less than $200, with many below $100. Rural people, who make up 70 percent or more of the populations in most developing countries, devote 70 to 90 percent of their labor to raising enough food for bare survival.

The U.S. Department of Agriculture has estimated that 92 percent of the Asian people, 38 percent of the Africans, and 29 percent of the Latin American population are living on diets which do not supply the recommended intake of calories.

Quality of diets is low

Increasing caloric intake is usually the first step taken to improve diets in the developing countries. This is done by growing more cereal crops—rice, corn, or wheat. The major resulting world food and nutrition problem is a need for more quality in the diet.

Inadequate food for caloric requirements results in weakness, fatigue, and inability to carry out the simplest tasks, and in its extreme form leads to starvation and death. These are quantitative nutrition problems.

Qualitative nutrition problems may better be classified as "hidden hunger." They are particularly serious for the vulnerable child from weaning to five years of age.

In general, the most widespread nutritional problem is a multiple nutrient deficiency of proteins, vitamins, minerals, and calories. The vast masses of children in the developing countries are usually given a high-calorie diet at weaning. Consisting of gruels made from cereals, the diet is low in protein and other essential nutrients.

An adult can meet his protein requirements if he consumes enough cereal crops to meet his caloric demand. This a child cannot do. The small infant has a protein need per kilogram of body weight about 2½ times greater than that of an adult. A suboptimal intake of essential amino acids from protein, or of protein and energy, is usually part of the multiple deficiency which arrests growth. The protein and energy deficiencies at the same time prevent other concomitant nutrient deficiencies from becoming acute.

If seriously malnourished children are given additional foods which supply energy and protein, their growth rate may be temporarily restored to normal. However, they may soon develop specific acute nutritional disease symptoms if their diet is inadequate in other nutrients. Thus, a partial correction of dietary deficiencies may do more harm than good.

A child consuming a diet low in both protein and vitamin A, for example, is so stunted in his growth, that he may "get by" on the small amount of vitamin A he receives. If he is then given enough protein to permit growth, he will need more vitamin A. If he does not get it, he may develop full-blown vitamin A deficiency, which can lead to permanent blindness.

Each year about 3 million children die either directly or indirectly of malnutrition. In many of the developing countries, 50 percent of the population die before reaching the age of 15.

Malnutrition causes retardation

Height-weight measurements for age provide the simplest index we have for assessing nutritional status. A growth retardation of two or three years has been found in the vast majority of children who reach the age of six in the developing countries.

Of even greater consequence and more concern are the usually undetected but potentially detrimental effects on learning ability, mental capacity, and behavior of the children who survive this impaired physical

growth. Recent evidence strongly suggests that prolonged malnutrition in infancy may cause permanent, irreversible mental, psychological, and neuromuscular retardation.

Infants who survive the early insult of undernutrition and infection are not to be construed as "the most fit," but rather as the ones who have managed to sustain life despite their marginal subsistence, persistent parasitic infestation, and recurrent infection.

Treat or prevent

In a recent study of the six Central American countries, conducted in conjunction with the Institute of Nutrition of Central America and Panama, we assessed the seriousness of protein-calorie deficiency among children under four. From our random sample, it was estimated that 69,000 of the children in this age group are suffering from severe Grade 3 protein-calorie malnutrition. Unless hospitalized, these children will die. These children require at least 90 to 120 days of intensive hospital care at a cost of $27 to $44 million.

Another 1.5 million children are suffering from Grades 1 and 2 malnutrition. They are on their way to serious Grade 3 malnutrition. The cost of supplying a protein-calorie-vitamin-mineral food supplement to prevent this disease varies between $12 and $23 million annually.

High-protein, cereal-fortified foods are available in Central America in the form of "Incaparina," which is now being manufactured and sold in Guatemala. In addition, USAID, in collaboration with the U.S. Department of Agriculture, is distributing a corn-soy-milk mixture fortified with the essential vitamins and minerals at a cost of about 8½ cents a pound. A hundred grams of this food will furnish one-third to one-half of the daily caloric requirements of a two-year-old child, and one-half to three-fourths of the vitamin and mineral requirements.

Some specific nutrient deficiencies

Vitamin A deficiency is a common cause of permanent blindness in infants in Indonesia, Pakistan, India, parts of Africa, and northern Brazil. The worldwide toll in human misery due to a deficiency of this nutrient is shocking. Yet the total vitamin A requirement of any child in the world can be supplied for less than 10 cents a year.

About 200 million people in the world are suffering from goiter, an enlargement of the thyroid gland due to iodine deficiency. Latin America is one of the most severely afflicted areas in the world. In some villages over 90 percent of the population have goiter.

Goiter can be prevented by adding minute quantities of iodine to the daily diet. Ten thousand persons could be furnished with iodized salt at a cost of less than $20 a year for the ingredients. In recent years, a few countries have initiated efforts to combat goiter through salt iodization, with dramatic success.

Beriberi results from a deficiency of thiamine and is found usually in countries consuming highly polished rice. It causes a high mortality in infants aged 3 to 6 months. In adults it causes wasting and paralysis of the limbs, edema, and eventually heart failure.

Lack of riboflavin is the most common vitamin deficiency found in the 33 countries we have studied. Riboflavin deficiency, while not showing such dramatic physical lesions as deficiencies in vitamin A, thiamine, or iodine, does impair metabolism of other nutrients.

Anemia affects 10 to 20 percent of the people in the 33 countries. Although lack of dietary iron underlies this disorder, other endemic diseases which contribute to blood loss or interfere with intestinal absorption are important contributing factors. Symptoms of iron deficiency anemia (often confused with "laziness") include weakness, labored breathing on exertion, and a constant feeling of fatigue.

Rising expectations

We need to break the vicious cycle of poverty, low productivity, high mortality, high morbidity, high infant deaths, and retardation of physical and mental development. We need action now, not 10 years from now, to subsidize the feeding of the preschool child. By this I do not mean a dole, but education and extension, reaching present and future mothers.

The peoples in the developing countries have a rising expectation of finding better housing, better food, better education, and better government. Millions of unskilled rural inhabitants have moved to the cities hoping to find steady employment, only to find they have been dragged into the money economy without money. The distance between the level of existence of the rural immigrant and that of the urban middle class man he hoped to become, has increased rather than diminished. In no case has the overall level of living really improved; in no case has democracy benefited; in no way is the world safer from famine, unrest, strife, and warfare as a result of the policy of rapid industrialization.

Yet the plight of the individual is frequently ignored in plans for the developing countries. Many recommendations concerning agriculture deal with land, supplies, and markets, rather than with man himself.

Nutrition and health scientists have evidently been unable to "sell" to Congress, to the USAID missions, and to the world, the clear fact that man needs to be treated with the same precise care that we apply to the production of hogs, milk, poultry, and crops.

We seem to have forgotten that the Land-Grant college system, which amalgamated research, education, training, extension, and demonstration, and which reached the user, the farmer, and the farm wife, were beyond doubt the wisest investment that our forefathers ever made.

The hope of assisting the developing countries to become self-sufficient can only be accomplished if we export, in toto, our concept of the Land-Grant college. Equally important, we must insure maximum use of local country resources, starting not only with land but with man himself.

We cannot export our technology directly to the developing countries, but we can export the techniques for developing a new technology

Technological Developments and World Food Needs

NYLE C. BRADY, Director of Research, New York State Colleges of Agriculture and Home Economics, Cornell University

It has been suggested that America's agricultural technology can solve the food problems of the world. This technology has given us an abundance of food in the United States. Why shouldn't it work similar wonders elsewhere?

This quick solution has not worked, however, when it has been put to the test. With a few exceptions, the technology applicable to our soils, climate, varieties, and animal breeds has generally failed when applied directly to the problems in tropical and sub-tropical countries.

However, the techniques of gaining new knowledge on which technology must be based are exportable. Our basic principles of research can be applied to filling present knowledge voids so that an agricultural technology can be created for the developing countries.

Specific knowledge voids

Tropical soils. In discussing knowledge voids, I would like to start with the tropics, since they contain most of the world's uncultivated but arable soil. Furthermore, it is in the tropics and semitropics that most of the hungry people of the world live. Unfortunately, most scientific and technical knowledge relating to agriculture has been developed in the temperate zones.

One area of our ignorance about the tropics concerns the nature and optimum management of the soils. Sometimes temperate zone technology has been successfully applied to tropical soils with only minor modifications. Other times it has failed almost catastrophically. Some failures are due to extremely heavy rainfall during at least part of the growing season. Others are apparently associated with the properties of the clays in some of the soils.

Adapted crop varieties. There is a pressing need for new high-yielding plant varieties and strains adapted to conditions in the developing countries.

Yields of food grains vary widely around the world, and the lowest yields are found in countries that need food the most. The "status quo" varieties in these countries are adapted to low soil fertility and age-old farming methods. These varieties respond sparingly to fertilizer applications or to improved management practices.

Our few striking examples of successful agricultural development have all included a genetic and plant breeding research program. Only when biological potential is bred into plants can fertilizers, pesticides, and improved cultural practices be effective.

Irrigation. An inadequate supply of water is a major limiting factor in crop production in the developing countries. Irrigation projects are being developed to change this situation.

Pest control. Paralleling the technological advances required in plant breeding will be those needed to protect crops from insects, diseases, and weeds.

In the tropics, year-round high temperatures and long periods of wet weather provide ideal environments for certain plant diseases and insects. Pesticides are sometimes ineffective or must be applied so often that their economic use is doubtful.

Chemical pesticides will need to be used in the developing countries to the extent practical, while new biological means of control must also be developed.

Animal production. Animal diseases are among the most important limitations to livestock farming and protein production in the developing nations. Some of the most devastating diseases in these countries have not occurred in America. While we have been fortunate to escape their scourge, we also lack experience in dealing with them.

Some policy leaders favor crop production priorities over any efforts to develop animal industries. But I would stress the importance of both to a balanced agriculture and human nutritional needs. While plants are superior in production of calories and total protein, animal products are decidedly superior in protein quality. Furthermore, vast areas of tropical rangeland could be harvested by animals.

Fortunately, there is a substantial reservoir of knowledge about livestock nutrition, breeding, and veterinary medicine principles that well could be applied to research on native animals.

The production package approach. In any program to increase food supply, a package of practices must be developed. Any one technological advance is relatively ineffective unless accompanied by other technological changes. For example, fertilizer applied to native varieties managed by primitive practices may actually decrease yields. The plants are not adapted to a high fertility

level and the fertilizer may stimulate weeds which crowd out the crop.

Successful production practices must be integrated with processing and marketing practices and with industries which supply such inputs as fertilizer and pesticides.

Processing and marketing. The movement of food products from farms to population centers is another area of developing agriculture that is a long way from its full potential of service to society. Dependable electric power, refrigeration, storage and transportation facilities, and marketing outlets, as we know them, are virtually nonexistent in the developing countries.

Here again, research, development, and extension programs must be developed "on the spot."

The Mexican success story

While the world food picture is dark now, there are shining examples of the progress that can be made.

One of the best examples is found in Mexico. Some 20 years ago, that country faced serious problems in food production. Wheat yields were 11 bushels an acre and other grain crop yields were low. Mexico was importing half of her wheat at great expense.

To combat this, the Mexican government created the Office of Special Studies within the Ministry of Agriculture and put its resources into an intensive research effort. Rockefeller Foundation staff scientists collaborated in the program.

After 20 years Mexico's food production has doubled. Average wheat yield is now 40 bushels an acre, with many farms achieving 80 bushels. During the two decades Mexico's population went from 20 to 37 million, yet her people's caloric intake climbed from 1,700 to 2,700 calories daily.

By 1966 wheat varieties developed in Mexico were being widely used in India and Pakistan. Superior corn hybrids have also been developed in Mexico, and are now being used to breed newer hybrids adapted to the conditions of Africa, India, and Southeast Asia.

Rice Research Institute

Another success story may be found at the International Rice Research Institute in the Philippines, which has been in operation since 1962 under the joint support of the Ford and Rockefeller foundations. In just a few years new varieties have been developed that are shorter strawed than the old varieties, make better use of sunlight, respond better to nitrogen, and are less susceptible to lodging. Attention has also been devoted to fertilizer practices, irrigation management, weed and pest control, use of power machinery, and systems of year-round production.

When the Institute was dedicated in 1962, rice yields of 4 or 5 tons per hectare were considered adequate under tropical conditions. During the dry season of 1965, seven varieties yielded more than 8 metric tons per hectare at the Institute. In 1966 one Institute selection produced more than 10 tons per hectare!

Maize improvement in Kenya

The Maize Improvement Program in Kenya is sponsored by the Kenya and U.S. governments and the Rockefeller Foundation. Initiated in 1958, this program has developed superior corn hybrids that already are being produced commercially. They are being offered to producers as part of a package plan that includes the use of fertilizer and prescribed cultural practices.

Successful programs characterized

From these programs, we can define some characteristics of successful development of technology to increase the world food supply.

- There must be continuity of financial and physical support.
- Research and facilities must be as good as those in developed areas.
- There must be long-term commitment of personnel.
- There also must be an underlying spirit of cooperation. Programs should be carried out at the request of the developing countries and should involve their own scientists as well as Americans.
- New scientists and extension leaders must be trained to make continuing progress a reality.

The three-way partnership

To achieve these characteristics requires cooperation on a broad scale. Inputs are needed from government, universities, and industry.

Government. The federal government must provide the mechanism and support for many of the inputs by industry and the universities. Government agencies must also develop their own research and education programs outside the United States. Lastly, the U.S. Government must press for greater inputs from other nations and for coordination of international efforts.

Industry. American industry is evidencing a growing interest in the world food problem. This is to the good, for research and extension efforts of government agencies and universities are of little force if not coupled with industry inputs. Seeds, fertilizers, pesticides, and adapted farm machinery must be available, and means of processing and marketing foods must be developed.

The universities. Our Land-Grant universities now face worldwide problems similar to those they have solved in the United States. If properly supported, these universities can furnish the specialists and resources to do the job.

There is much that individual institutions can do alone. A single university, however, cannot accept certain responsibilities.

What is needed is the *consortium.* A consortium of several universities could attack problems too large for any one university to solve alone. Consortia could probably make their greatest contributions through overseas research and graduate educational centers of excellence.

I would like to conclude on a note of urgency. Clearly, we are running out of precious time. Many workable programs and concepts are available to us; the challenge lies in blending them to create new and powerful sources of knowledge.

The human factor is expressed in institutions, cultures, and social and personality systems that sometimes constitute obstacles to change

The Human Factor in Programs for Improving Agriculture and Nutrition

IRWIN T. SANDERS, Vice President, Education and World Affairs

TARGETS of change, agents of change, and consolidators of change all represent the human factor in programs to increase agricultural production and improve nutrition.

Usually the targets of agricultural change programs in the developing countries are the peasant and his wife. Perhaps we can best understand them if we think of their involvement in three interpenetrating systems — the cultural, the social, and the personality.

The cultural system

The cultural system comprises beliefs, values, assumptions, and taboos about the nature of the universe and man's place in it, as well as rules for his social behavior. This system helps to determine attitudes toward food and toward agricultural practices.

Beliefs about food. Ward H. Goodenough, pointing out that food may have a symbolic role far beyond its connection with hospitality, writes: "Food taboos . . . enhance the sense of purpose and dedication people seek to achieve in their spiritual life. In some societies eating is itself a religious rite. . . . What to the administrator appears to be a proposal to change eating habits may appear to the community as a proposal to change religious practices."

Cultural differences about food are expressed in other ways. Feasting may be important in transacting business, for example, or food habits may mark social or class differences.

Progress versus fatalism. Other values not associated with food affect the adoption of good agricultural or nutritional practices. Some of the most important of these are connected with fatalism, apathy, and negativism toward change itself.

Fatalism in some shade or other, is part of the religious orientation of many peasant groups. But there are probably more basic reasons why an individual farmer hesitates to try something new.

His way of life is often built around adjustment to nature and not to its mastery. Everything has to be done in the proper season. Change is not so much an attack on an abstract concept of fate as on his view of nature around him.

His agricultural practices, despite their backwardness, have stood the test of time. He cannot afford to change unless convinced that another way is better.

Failures of previous innovations may explain part of his negativism.

The social system

The social system includes a set of mutual obligations that people expect of one another.

My own observations of rural cultivators have led me to believe that they are more influenced to refuse or accept new practices by the presumed reactions of their family and fellow villagers than by some abstract idea of fate or efficiency.

In Nigeria, for example, the extended family ruled by elders is very much a part of the social system. Suppose a farmer accepts 50 Nigerian pounds from a government agent to cover the cost of clearing some land for production. As soon as this is known, an elder may say to him, "You are rich now. You should contribute 10 pounds to the family fund for educating our young people." According to the rules of the social system, the farmer has to contribute. Later the government agent learns of this contribution and accuses the farmer of dishonesty. But to the peasant maintaining good relations with his elders is more important than pleasing the agent.

Landlord-tenant relationships. Many farmers in developing countries work for landlords who have little interest in rural areas as long as they get their income.

It has been argued that redistribution of the land to the cultivators themselves would greatly increase agricultural productivity by increasing the farmer's incentive. Land reform without education and community development programs, however, may be a retrograde step economically. The small holdings may be operated even less efficiently than the former large holdings.

The reform does represent a crack in the traditional structure, giving the peasant a reason for hope and for accepting innovation.

Informal groups. The social system includes many informal groups — tavern or teahouse cliques, neighborhoods, and working bees among the women. These groups help to form public opinion about many things, including the practicality of changing a farm practice.

Formal social structures may be institutional, like the school, the local government, or the local religious

center; or they may be organizational, like a purchasing cooperative.

Although these structures are supposed to bring new ideas into the villages, they may fail because they are backward or other-worldly with no concern for the present; or they may be urban-oriented with no concern for rural problems; or they may be devices for doing a specific job with no educational influence.

Personality system

The peasant, his wife, and his neighbors are not simply carriers of culture or social atoms; they are vivid personalities who make independent decisions.

Social psychologists have noted that people in similar social positions tend to have a common personality configuration, but even then individual behavior variations are important. This is germane to our consideration here insofar as it helps us understand what kind of people accept change and what kind postpone or oppose it.

According to studies in some of the developing countries, innovators (or people who are first to try new practices) tend to have a higher socio-economic status than other villagers; are more active in community affairs; and have more contact with various agencies.

Analyses of why personalities develop to the point that some innovate while others do not will give valuable clues about obstacles to change.

Agents of change

The peasant and his traditional ways are not the only obstacles to change. Some agents of change and their way of doing things may in themselves present quite a few obstacles. I refer in particular to the planner, the program specialist, and the foreign expert.

The planner. In seeking rapid modernization, the leaders of developing countries have become enamored with national plans.

Despite their devotion to change, plans and their planners may constitute an obstacle to agricultural productivity and improved nutrition. One reason is that the planner, in emphasizing industrialization, does not give agriculture a large enough role in economic development. Fortunately, the most experienced planners are now stating that neglect of agriculture was a mistake.

A second obstacle raised by planners has been their failure all too often to allow enough expenditures for the non-economic sectors of development, including education as well as social welfare measures.

The program specialist. A key link in any system of planned change is the program specialist who makes direct contact with the people whom one hopes to change. Such a person may be an extension specialist, a community development expert, a public health nurse, a nutritionist, or a rural welfare worker. These people facilitate change to the extent that they know their subject matter and can communicate with rural people.

Far too often, however, program specialists in the developing countries are obstacles to change. The specialist may order people to change instead of educating them to change. His language and demonstrations may be too theoretical for the villagers. Or he may raise hopes which are not fulfilled.

While it is easy to criticize the program specialists, they face serious difficulties — for example, insufficient transportation, inadequate training, or low bargaining power with the officials upon whom they depend for delivery of goods and services.

Foreign technical assistance experts. Many developing countries are short of people qualified to give technical advice on increasing food production. At present, the skills and knowledge of foreign experts are needed. Many such experts are making outstanding contributions.

Others, however, are either barely competent or are downright obstructionistic through no desire of their own. They may be unable to adjust to strange cultural and social situations, or they may have personality traits that detract from their effectiveness.

Consolidators of change

Once the agents of change have introduced innovations, the gains need to be consolidated. This involves the distributive mechanism, government bureaucracy, and the educational system.

The distribution system. One obstacle to change is an inadequate distribution system. Often farmers or homemakers cannot get the supplies for carrying out a new practice they have decided to adopt. Or farmers may not be able to market the products resulting from improved practices. If crops remain unsold or if prices do not cover production costs, innovations do not become consolidated.

Officialdom. Some distribution problems are related to obstacles presented by the bureaucracy of the developing country.

The efficiency with which the bureaucracy provides needed rural services affects the consolidation of new practices. Also, the attitude with which the bureaucracy discharges its functions influences the peasant's reaction to government-sponsored changes.

The educational system. The schools make important contributions to agricultural production simply by teaching people to read and to keep accounts. Education can also aid better farming and nutrition by giving pupils insight into cause-effect relationships. Another contribution is to make village boys and girls aware of the larger world about them.

Despite these contributions, the educational system also creates obstacles to change in many villages. Textbooks and courses are prepared on the assumption that every rural youth will enter a university. Teachers often make little identification with local needs. As a result the village youngster sees little relevance between school and his everyday life.

If a country takes seriously its efforts to increase food production, it will devise educational offerings in rural areas that will direct some attention to agriculture and to the problems of everyday life.

DAVID E. BELL, Vice President, The Ford Foundation

Government policies affecting the world food problem are clearer and firmer now than they were 10 years ago

U.S. Domestic and Foreign Policies and World Food Needs

In recent years our ideas about U.S. domestic and foreign policies in relation to world food needs have been changing rapidly. I would like to discuss briefly some key elements of our present position and some of the issues that still lie ahead.

Policy toward population growth

The first policy issue does not have to do with agriculture but with population growth. U.S. policies in this respect have been completely reversed during the past 10 years. We are now prepared, under the Foreign Assistance Act, to provide training and technical advice as to family planning, and to finance the importation into aid-receiving countries of contraceptives or the machinery to make them.

Although we have a firm national policy toward family planning, we still cannot regard it as a closed issue. For evidence is accumulating that existing contraceptive techniques are too expensive or too sophisticated for widespread use in developing countries.

Consequently, the greatest need at present is for more research to find simpler and cheaper means of preventing conception. In this respect, government policies are still far from satisfactory. The National Institutes of Health are spending less than $10 million a year on this vitally important problem — less than is spent by one private foundation.

Even if the government joins the private foundations in supporting research on a larger scale, it will probably be at least a decade before we can expect sizable reductions in population growth in the less developed countries. For as and when we have better technology, there will remain the enormous tasks of education and of distribution.

Impressive evidence has been accumulating that a strong motivation toward family planning programs exists in developing countries. This is due to far more than simple concern about food supplies. Indeed we can probably say that in most developing countries people do not usually become aware of the population problem initially in terms of hunger. In Latin America, even though there is much serious undernourishment, the single most discussed problem regarding population growth is its relation to maternal health. In other parts of the world, population growth is seen first in the form of relentless pressure for more schools, more jobs, more housing.

Stated most broadly, population growth appears to the people of low-income countries first as a problem of family and child welfare rather than as a problem of potential famine. The evidence is unmistakable that most parents the world over want to plan their families so they can provide for the health and education of their children and for the health of the mothers.

Our present programs can therefore take a relatively simple form; find techniques that will be effective in low-income countries, and make them available to the people there.

Support of agriculture in developing countries

The second policy issue concerning world food needs relates to agricultural production in low-income countries. Here also U.S. policy today is clear and firm. All our instruments for foreign assistance — including Public Law 480 — give highest priority to increasing agricultural production in developing countries.

This policy of all-out support to food production in less developed countries is a recent one. For years U.S. policy on this issue was ambiguous. We provided technical assistance and other economic help to increase farm output abroad, but at the same time we tried to keep our aid from increasing the output of crops we ourselves had in surplus. And we made surplus food available so readily that we may well have depressed price incentives for the farmers in developing countries.

A series of important legislative changes in 1966 have given us a much clearer policy stance. Today P.L. 480 surpluses are to be made available only to countries that have self-help programs leading to larger local output. A special office in the Agency for International Development has been established to give coherent leadership to all types of U.S. assistance to agricultural production and to make sure that food production in developing countries receives first priority in our economic aid program.

Two sorts of obstacles

Despite the improvement in U.S. policies, two sorts of obstacles are ahead.

The first obstacles stem from the inherent difficulty of increasing agricultural output in low-income countries. Fifteen years ago many of us thought that all we needed to do was to make U.S. technology available in less developed countries. But this has proved to be a monumental misconception.

We have learned that farmers in low-income countries — like farmers anywhere else — make canny judgments about their own interests. It does no good, for example, to demonstrate that applying fertilizer will raise a farmer's output of wheat if the relative prices of wheat and fertilizer are such that he won't make money. Now many countries are adopting policies that will provide price incentives to producers.

We have also learned that U.S. technology cannot be directly transferred. Seed varieties and cultivation methods that produce bumper crops here may fail entirely in other countries.

What we do have is a body of scientific knowledge, and methods of scientific research and development, that have universal application. We need to establish systems of research and experimentation which will produce locally adapted agricultural technologies for developing countries.

Another important lesson of these last 15 years is that agricultural improvement in the developing countries cannot be achieved by itself; it must be part of a general economic development. Internal markets must grow, and these in turn depend on rising urban and industrial incomes. Transportation, storage, and marketing must be improved. Fertilizers, insecticides, and machinery must be manufactured or imported. Financial arrangements must be created, and educational and research systems must be developed.

The inherent difficulty of increasing agricultural growth in the developing countries is thus a many-faceted, enormously complex problem. We must be prepared to invest major resources for many years if we are to have any hope of success.

It is precisely here that the second set of obstacles arises. In recent years, just as we have begun to understand better how we can help less developed countries and as we have become increasingly aware of the urgency of doing so, there has been a considerable erosion of Congressional support for foreign assistance.

Members of Congress criticize foreign aid for various reasons, such as its supposed relationship to our involvement in Vietnam, or its supposed incompatibility with a strong anti-poverty program at home. In a different forum, I would be prepared to argue the merits of these views, but the relevant point here is that, whatever the merits of these criticisms, they could be very damaging to the U.S. policy of assistance in meeting world food needs.

These comments about U.S. government policies are not meant to imply that government action is all that is necessary to help the agricultural progress of developing countries. Far from it. The Rockefeller, Ford, and other foundations can and should do more in research, training, and technical assistance. U.S. universities also can do more to adapt their educational, research, and service practices to the needs of today's international life, and finally, private businesses can pursue opportunities to invest in agriculture and related enterprises in developing countries.

But all this is not enough. Foundation and university resources are limited, and the opportunities for U.S. private business will in general become larger as developing countries come closer to being economically self-sustaining — that is to say, after government economic aid has done its job. I think the leaders of foundations, universities, and business who have had the most experience in the less developed countries would agree that, in the early stages of assisting these countries, there is no substitute for a sizable and well-designed government economic aid program.

Policy toward our own agriculture

The last issue I'd like to discuss is the problem of our policy toward our own agriculture in the light of world food needs.

The basic question posed for American agriculture concerns the requirements for U.S. food exports over the next decade or so. The answer is not easy. It depends on estimated population growth, income, and economic growth in the developing countries; and also on estimates of agricultural production in developed countries other than the United States and on assumptions about their policies regarding trade and aid.

Several careful attempts have been made lately to reach conclusions based on reasonable estimates of these various factors. The general consensus seems to be that, during the next 10 years or so, the United States will not need to bring into production all its unused capacity to meet world food needs.

There will continue to be need for U.S. aid in the form of food commodities to deal with short-run difficulties such as drouths, and to deal with some longer-run situations while economic growth is being established.

The major long-term interest of U.S. agriculture, however, is in trade, not aid. To this end it is important, first, that U.S. policies be aimed at keeping U.S. agriculture competitive in world markets. It is important, second, that U.S. policies strongly support the economic progress of developing countries, so that they will become larger commercial markets. It is important, finally, that U.S. policies strive to maintain open access to world markets for our agricultural products.

In this latter connection, there seems to be at present a serious risk of reversion toward protectionism. Strong forces in Congress are urging higher U.S. tariffs and tighter U.S. quotas on such commodities as steel and textiles. But if greater restrictions are placed on U.S. imports, other countries are sure to retaliate with greater restrictions on our agricultural exports.

We must invest in new knowledge now if American agriculture is to meet future demands on its productive capacity

U.S. AGRICULTURE and the World's Need for Food

GLENN S. POUND, Dean and Director, College of Agriculture, University of Wisconsin

OUR PRESENT policy of agricultural assistance to developing countries emphasizes the need for these countries to help themselves. The sharing of American produce for nondollar sales is considered as strictly an interim aid. But the developing countries will simply not have time to get geared up to carry their own needs before massive aid is required. As a result, we can expect great stress on our productive capacity in the future.

What probable impact will this crisis have on the next two decades of American agriculture? What changes are ahead? What planning should we be doing now? I should like to discuss these basic questions.

Limitations on capacity

American agriculture is so productive that many believe we can quite simply increase our future productivity as our needs increase. We do have untapped potential, but we must recognize that there are limitations. We cannot escape from certain facts:

More than a million acres of cropland is being lost each year to urbanization. America has considerably more land than the 350 million acres now used for crop production. But to bring much of our unused land into production would not be economically feasible and would furthermore mean abandoning gains that have been made in conservation.

U.S. population increases will be very significant. In spite of birth control programs, our base of women of childbearing age is growing.

We have put to use virtually all the production knowledge available. We cannot expect the yield increases of the past two decades to continue unless we create additional production information. This means research, and more research.

Domestic and export markets

The strength of our domestic markets will largely depend upon our per capita purchasing power and our population increase. Our economy, as measured by gross national product, is projected to increase by about 4 percent a year for the next 10 to 15 years.

With increased affluence, there will be even greater demand for animal protein, fresh fruits and vegetables, and convenience foods than in the past two decades. Our domestic markets will be further strengthened by our population increase, which will add another 50 million mouths to feed by 1980.

Exports of agricultural products have been increasing very rapidly in the past 10 years. In 1966 export sales of wheat, feed grain, and soybeans were each over a billion dollars.

Indications are that our export trade will demand more and more of our productive capacity. With the growing demand for high protein feed for both domestic animals and humans, soybeans are destined for an even more enviable position in the world's agricultural economy than they have today; and, in world trade, soybeans are almost exclusively an American product.

Also, exports of American feed grains should increase sharply. Western Europe, Japan, and Taiwan are consuming more livestock products but do not have vast acreages to devote to feed grains. As other nations become more affluent, they too will probably shift to more animal protein.

Ups and downs can be expected in the future export pattern of wheat, depending on wheat crops in the rest of the world and also on rice production. Prospects for vastly improved rice production in the tropics, resulting from research at the International Rice Research Institute, could reduce world markets for wheat.

The recent Kennedy Round of tariff negotiations will certainly affect our export trade. Our country will be open to more products from abroad, but so will foreign markets be more open to us. Quality of product will increasingly control sales and no nation can build in higher quality than America.

The structure of agriculture

All evidence indicates that the trend toward fewer but larger farms will continue. The much respected "family farm" is not likely to pass from the American scene, but it will change greatly in form.

Two somewhat interdependent factors, farm incomes and the availability of farm labor, will be paramount determinants of the structure of agriculture in the 1980's and beyond. In 1966, the per capita disposable income of the on-farm population was about $1,750; that of nonfarm persons, about $2,675. The structural changes in agriculture must be such as to yield more income to the producer.

It is anomalous that we still have surplus manpower in rural America

and yet a prime factor in many farmers going out of business is the difficulty of obtaining hired help. This places sharp focus on the social and welfare deficiencies of rural America. The farm operator is in a poor competitive position in securing labor because he cannot provide adequate income and a satisfactory social environment.

As we look at the nature of farm operations, we see a continuation of increasing specialization. General diversified farming will disappear.

With increased specialization, the farmer will become more vulnerable, for he can take fewer risks. He must have sophisticated management services. He will come to depend on computer services not only in keeping records but also in making decisions as to planting schedules, fertilizer and feeding formulas, and similar matters.

Support needed for research

American agriculture is incredibly successful primarily because we made the investments necessary to create a great reservoir of agricultural knowledge and a great pool of trained manpower. Today we are spending the dividends on these investments. The future of American agriculture will be secure to the extent that we continue to invest in new knowledge.

State and federal expenditures for agricultural research in 1965 represented only 1.1 percent of the $40 billion cash receipts from farming in that year. This is hardly an adequate research investment to secure the future of the most important underpinning structure of our economy. A well-managed business corporation invests at least 3 percent of its sales in research and development, and some companies invest much more.

Production of animal protein. Although animal protein is not essential in human nutrition, it does offer a fuller complement of amino acids than plant protein and also enhances the flavor of diets. Americans have shown a great preference for animal protein, and our affluence has let us consume large amounts of meat.

As population pressures increase, our consumption levels of meat cannot be maintained without research breakthroughs which will lower production costs. Emphasis is needed on the following lines of research:

Reproductive efficiency. The increase per breeding unit is now too low. We need new information about the physiology of reproduction.

Feed utilization. Phenomenal gains have been made in feed utilization in swine and poultry, but comparatively little progress has been made with ruminants.

Breeding. Much of the recent advance in poultry and swine production has been due to breeding programs. Such programs could probably increase production efficiency in cattle.

Disease control. Diseases cause an annual loss of some 15 percent in our livestock operations. Our basic research in veterinary science must be stepped up and the number of veterinarians must be increased.

Aquatic animal protein. U.S. investments in sea research are relatively small. Our knowledge about location of fish, the engineering of harvesting and processing operations, and feeding methods in "sea farming" is inadequate. We are now beginning to invest in research on such problems, but our time schedule should be stepped up and the magnitude of support greatly increased.

Restructuring food plants. We are undoubtedly approaching the upper limit in yields from some of our crops with our present germ plasm. We are faced with the great challenge of rebuilding our food plants to break yield barriers.

While we know a great deal about soybeans, for example, we yet know so little. Average soybean yields have increased only 60 percent in the past 30 years while corn yields have trebled. Why don't soybeans respond to increased fertility and water as cereal grains do? Why should 100 bushels per acre be such a coveted record?

The soybean is one of 15 species that man really depends on for his food. The others are rice, wheat, corn, sorghum, barley, sugar cane, sugar beet, potato, sweet potato, cassava, bean, peanut, coconut, and banana. We need comprehensive, integrated research programs on these plants in an effort to build more efficient biological systems.

Synthetic and substitute foods will likely become one of the most significant facets of agriculture before the end of this century. Many of the raw products going into such foods will be "agricultural," meaning an ever-increasing market power for agriculture.

Soybeans are now the leading source of raw protein for this growing industry, but leaf protein, particularly from alfalfa, could well become as important.

Tropical countries have an immeasurable capacity to produce plant tissue. We know virtually nothing about the protein content of tropical plants. Developing countries cannot now divert research resources to this capability, but America can and should.

Increasing water resources. Increased agricultural productivity in the United States will largely depend upon increased water resources. Although breakthroughs in desalination of ocean water and in weather modification may be coming, wiser use of present water resources offers the greatest potential for agriculture in the near future. High priority should be given research on this subject.

Environment quality. We have come dangerously close to "saving our lives but losing our souls." Our landscapes are cluttered, our lands and forests have been misused, and our soil and water systems are polluted to a point of alarm.

In a mad rush to almost total urbanization, we have piled millions upon millions in our cities and have stripped nature out of the lives of vast numbers of our people. At the same time, we have devitalized much of rural America in terms of social and economic assets.

Our social scientists must, by their research, pave the way to a greater public awareness of the imbalance we are in, an awareness that would result in governmental policies for a more balanced use of our resources.

ILLINOIS AGRIBUSINESS and the World Food Demand

CLIFTON B. COX, Group Vice President, Armour and Company; and Chairman, Agricultural-Business Relations Committee, Illinois State Chamber of Commerce

In no other country and at no other time in our history has agriculture provided so well for so many people as it does in the United States today. It is the foundation upon which our great industrial economy is built.

Agriculture is our biggest industry, employing 5.6 million workers and creating millions of non-farm jobs. It takes about 1.4 million people to supply our farmers and another 10 or 11 million to store, transport, process, and merchandise the products of America's farms.

Yet I believe there are misconceptions about America's economy in many of the underdeveloped nations. They have embarked on programs of industrialization, sometimes at the expense of their agricultural progress. A dream of busy factories, increased wealth, and happily employed citizens has lured these nations into a trap. The economy of new nations, as well as of the older countries, needs a balance. Agriculture must be on a strong basis before a program of industrialization can succeed.

Success of agribusiness

In our own country we have a partnership sometimes referred to as "agribusiness," in which farm production and marketing are heavily dependent on one another.

Illinois is an excellent example of the success of agribusiness. No other state ranks as high in so many activities. Illinois is third in agriculture, fourth in manufacturing, third in retail sales, first in transportation, and first in exports.

Agriculture itself ranks as big business in Illinois, with 85 percent of the state's 56,400 square miles devoted to farming. In 1966 total cash receipts from farm marketings were over $2.7 billion. This was exceeded only by California's $3.9 billion and Iowa's $3.4 billion.

Illinois enjoys an advantageous geographical location. This state is the nation's rail center, has the third most extensive highway system among the states, and is served by the world's largest inland water transportation system.

Within the state are almost 1,900 food processing plants — more than in any other Midwestern state — and 129 businesses engaged in the wholesale distribution of farm machinery and equipment.

Some disturbing elements

While we are now enjoying prosperity in the agribusiness community, some disturbing elements are in the picture. We have a variety of interests, including agriculture, transportation, industry, banking, education, and government, but each sector represents only a narrow portion of the whole field.

It seems to me that the different groups are not united in a common effort to evaluate agriculture and help supply world food needs. Who now is equipped to analyze the place of agriculture objectively? Who will speak for agriculture in formulating domestic and international policy?

Farm organizations are divided. Some are trying to serve commercial agriculture; others are trying to serve rural social interest; while still others, it seems, are trying to get publicity and trying to change the basic framework of agriculture.

In addition, there are the commodity organizations. We have the cattlemen, the cotton men, the swine growers, the fruit and vegetable associations, each group sometimes trying to get special concessions for its particular commodity.

Then we have the unorganized segment of "businesses related to agriculture," including meat packers, food processors, wholesalers, and retailers. Many of them acknowledge that they are not working for a program to promote total agriculture.

The U.S. Department of Agriculture is becoming consumer-oriented. It has increasing regulatory functions, with actual power to destroy. While the Department at one time worked for the total good of agriculture, there is now some question whether it is not at times an actual adversary to certain commercial agricultural groups. Farm problems are many and probably a single farm policy cannot solve them all. Commercial agriculture represents one set of problems; rural poverty, an entirely different set.

Land-Grant colleges have recently reoriented some of their work. Many professors are now international travelers. Some departments are getting substantial grants from foundations without depending in a major way on appropriations from the home state.

Likewise, I am concerned about state departments of agriculture. What they are trying to do is not clear. Some of them are getting into politics without serving as coordinators for agriculture within the state.

We in the Agricultural-Business Relations Committee do not feel we have found the answer. We do believe, however, that some organization could be put together for each state or for the country, with the group working for the benefit of all.

Exports and the Future of Illinois Agriculture

ROBERT M. SCHNEIDER, Director, Illinois Department of Agriculture

Illinois is the number one agricultural export state. We have been number one for four years, but received an extra boost recently by worldwide distribution of a publication entitled "Illinois Agriculture, Its Impact on U.S. Farm Exports." Trade missions and participation in international food fairs are also important in finding foreign markets for our agricultural commodities.

We are the number one producer of soybeans, swiss cheese, red clover seed, horseradish, onion sets, ornamental shrubs, and cut roses. Horseradish might seem like a minor commodity, but when you consider that we ship over 100,000 tons to Germany alone each year, it adds up in dollars and cents.

Facilitating shipments

Illinois's geographical location offers many assets in foreign trade, and we have tried to use these assets to our best advantage. We have, for example, exported record shipments of grain on the St. Lawrence Seaway every year since it was improved.

Another step we have taken to facilitate our exports is in-transit inspection of grain moving along our waterways. The idea of doing this occurred to me five years ago, when I was Superintendent of our Division of Grain Inspection. The plan finally became a reality on September 25, 1967.

We leased a boat and named it Ceres after the goddess of grain. As a grain barge enters the East St. Louis market area, our boat will cruise alongside and one of our inspectors will board the barge and obtain a sample of the grain. The sample is separated, sacked, and marked on the Ceres, and is taken to the East St. Louis grain inspection office for grading. The certificate is made available to the shipper within 24 hours so that he can present it at his destination.

With this system, the barge does not have to tie up anywhere along the way. Previously, barges might be tied up 3 to 15 days when the harvest season was at its peak. By eliminating this delay we are saving money for the shipper and for the farmers.

The Mississippi River is our proving ground for in-transit grain inspection. Should this system prove as successful as I believe it will, we will look to our other large rivers.

Technological revolution

Our records in production and in exports do not necessarily mean that all is well. We are faced with serious problems, in which two factors are important. One factor is the increasing speed of the technological revolution, which is altering the very structure of American farming.

Modern technology has changed at an ever-increasing rate over the past 25 years. Farmers have lowered their per unit costs with new machinery, chemicals, fertilizers, and even computers. Yields per acre and output per man hour are both increasing much faster than the demand for farm products. As a result the United States has excess capacity — more cropland than it needs and more manpower on farms than can earn a good living.

With this trend, it is imperative that serious thought be given to rural development. Too many of our rural areas have no industries offering job opportunities. Yet if the small farmer is to stay in business, he needs to supplement his income with other work.

Growing demand for food

Another factor in the problems we face is the growing world market for food. While other parts of the world are faced with tremendous population growth, our own country is growing little faster than 1.4 percent in population. This means we are still going to have to find foreign markets for our products.

At the same time that we want to expand our foreign markets, populations in hungry countries are growing too fast for any one country to relieve the crisis. The food-population balance will have to be restored through a combination of population planning and expanding food production in the hungry countries themselves. By all means food aid must be available for disasters, crises, and emergencies and as part of short-term plans for economic self-help. Food aid, however, should be coordinated with long-run aid programs that will provide incentives for local food producers.

The developing countries, to feed their masses, are going to have to learn the technology necessary to increase their own food production and most of all to become educated in population planning. They will need to build and staff local institutions for research, education, credit, and the other functions needed to support a modern agriculture. In doing these things, they will need the help of experts from this country as well as other U.S. assistance.

Where do we look for the leadership so needed to meet these enormous demands? Right here, in this university and others like it! All the urgent situations existing today and tomorrow will have to be faced by our young people. The universities have the responsibility of equipping these young people with the weapons they will need to meet these problems.

Teams of experts from U.S. Land-Grant universities help to build similar institutions in the developing countries

Land-Grant University Involvement in Overseas Agricultural Programs

LOUIS B. HOWARD, former Dean of the College of Agriculture, now Director of International Programs, National Association of State Universities and Land-Grant Colleges

THE PRESENT large-scale commitment of American Land-Grant universities to overseas programs dates back to President Truman's famous Point Four pronouncement, made during his inaugural address on January 20, 1949.

In part he said: "We must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas. . . . Our aim should be to help the free people of the world, through their own efforts, to produce more food, more clothing, more materials for housing, and more mechanical power to lighten their burdens."

It was abundantly clear at that time that an *evolution* must occur in the agricultural production of developing countries lest a *revolution* result. To achieve this evolution, was it not logical to turn to the Land-Grant colleges that had been the principal architects of American agricultural efficiency? Why not, by means of a system of government contracts agreed to by the host countries, simply employ Land-Grant university staff members to transfer American agricultural know-how to underdeveloped countries?

By 1951, the "university contract" program was launched. Under this plan, the federal government contracted with Land-Grant and other universities to undertake programs of agricultural and other assistance to the underdeveloped countries.

Early difficulties

In the early contract programs, individual American advisers were commonly sent to overseas universities, research laboratories, government ministries, or state administrative units to work as specialists in the various agricultural disciplines such as soils, crops, animal science, home science, and agricultural economics.

Often the advisers taught one or more courses and undertook limited research projects on problems of immediate concern in increasing food production under local conditions. They served as counselors to their native counterparts and also sought to convince government officials of the need to increase agricultural inputs such as irrigation, fertilizer, pesticides, improved seeds, and technical information.

Technical assistance often had to be interpreted very broadly. Advisers frequently worked in the fields to demonstrate the dignity of physical labor. Veterinarian advisers were called upon to maintain the health of the people as well as of animals.

Advisers in home economics were mainstays in teaching not only the principles of nutrition, but also those of sanitation and food preservation. They brought to many of the women in the developing countries a sense of belonging to the human race rather than living as chattels.

These efforts were noble and were significant in a limited way. But the advisers were too few and too often diverted from their principal competencies. And they could not perpetuate the advances they had made.

It was too costly to bring large numbers of persons from the underdeveloped countries to the United States for training, and besides there were problems in this practice. Some learned well but returned to their home countries only to find themselves without prestige or influence. Others maneuvered to remain in the United States where they could receive a good salary. Still others developed a sophisticated approach that was suitable for solving the highly specialized problems of American agriculture but that had little application to the primary problems in their home countries.

New institutions developed

It soon became apparent that progress was not being made fast enough. Population growth seemed to be outrunning the increase in food production, and American food surpluses were being exhausted. A greater effort had to be made to increase indigenous food production.

Efforts to change agricultural systems by advising governments and faculties of established universities were proving to be frustratingly slow. Certainly, long-established policies of ongoing overseas universities were not to be changed by one or two Land-Grant spokesmen. Nor could our universities spare enough of their staff members to infuse the new approach into the bloodstream of the overseas universities.

The logical solution seemed to lie in building new institutions which would develop their own traditions within the general concepts of our Land-Grant universities.

With fairly general acceptance by the host countries, technical assistance shifted in emphasis toward institution building. Teams of five to fifteen or more professionals, under a group leader, were assigned to one location. This arrangement tended to replace the individual assignments of earlier days.

Sometimes an entirely new university was planned where none had existed before, while other times a number of existing colleges, research facilities, and experimental fields were consolidated into a new "super" university. Between these two extremes were institutional structures with varying degrees of compromise.

Both extremes in Illinois program

Both extremes are to be found in the programs of the University of Illinois in India. The Uttar Pradesh Agricultural University is a completely new university at Pant Nagar, a village near the foothills of the Himalayas. With no existing buildings, faculty, student body, or traditions, it was possible to plan a new university dedicated to the Land-Grant philosophy.

Such a situation, however, was not an unadulterated blessing for there were the numerous problems of pioneering. American advisers were called on for judgments on all manner of questions, many rather remote from normal educational affairs. Not only did classrooms, laboratories, offices, and dormitories have to be designed and constructed, but all the affiliated services and facilities required planning.

At the other extreme of institution building, the University of Illinois has helped to forge the Jawaharlal Nehru Agricultural University from a number of existing units, some many miles from the mother campus in Jabalpur. Here the problems centered on the integration of units, some with long traditions, others relatively new but with great aspirations for development as independent units. Obviously a different kind of ability was needed to solve these problems than those at the Uttar Pradesh Agricultural University.

Problems and progress

Successful institution building requires a firm faith and enthusiastic support that will endure until the university can achieve a position of utility to society and respect by the government and the people.

A viable university also requires indigenous manpower to staff it. The less developed countries vary widely in availability of qualified academic manpower. In some, such as India, there exists a considerable reservoir. Many Indian nationals have been well trained in classical Indian universities or in outstanding universities abroad.

Many African countries, on the other hand, have a dearth of manpower trained to staff the new universities. As a case in point, in a search for indigenous talent to staff a new college in Sierra Leone, only one native could be found who possessed a Ph.D. in any subject closely related to agriculture. In such circumstances, foreign personnel must be used for a time and native personnel must be urged to take advanced study in the United States.

In spite of the problems, the program of institution building has made good progress. A number of new universities with strong agricultural orientation have already turned out one or more classes of graduates.

Extent of present program

The principal source of funds for international agricultural programs is the Agency for International Development, which at present is financing the services of 1,200 agricultural experts in 55 countries. Although some of these experts come from the U.S. Department of Agriculture and from AID itself, most are from universities, predominantly Land-Grant institutions.

As of June 30, 1967, 71 universities were involved in various kinds of technical assistance projects in 39 countries. In addition, some of the universities involved in overseas technical cooperation, as well as some other universities, train foreign nationals, conduct research, or provide technical support to AID both in the United States and abroad. Altogether, 124 universities are involved under 205 contracts projected to cost nearly $194 million.

Contracts classified as agriculture, agriculture-education, or veterinary science total over $55 million. In addition, many contracts with other classifications encompass agricultural components. It is clear that more than a third of the technical assistance activities performed overseas under AID contracts consist of agricultural programs carried on by Land-Grant universities.

Of the 68 Land-Grant universities, 25 are now engaged in AID contract programs of technical assistance in agriculture to host countries. Several universities hold more than one contract and operate in more than one country. The University of Illinois, for example, has programs in India, Thailand, and Sierra Leone, and recently concluded one in Jordan.

In addition to the AID-financed projects, the Ford and Rockefeller foundations have made a number of grants to Land-Grant universities to support international agricultural projects.

Prospects for the future

University administrators have come to accept overseas activities as a legitimate — even desirable — means of developing a broader educational offering and acquiring a new institutional prestige. A serious effort is being made to develop a new profession of workers in international agriculture. Recognition of such a profession can result in higher standards of performance, appropriate goals and rewards, and greater contributions to the solution of some of the world's greatest problems.

Regardless of the present decline of Congressional support for international education and foreign aid, it is inconceivable that such programs will not be carried forward for a number of years. In the foreseeable future a very high priority will fall on the colleges of agriculture as the world food-population pinch becomes ever more acute.

University of Illinois Efforts in International Programs

In recent years the University of Illinois has been helping to develop two Land-Grant type universities in India and one in Sierra Leone. Joseph Kastelic, who served two years at the Njala University College in Sierra Leone, suggests some long-range plans for that country. Robert J. Webb, having served two different assignments in India, evaluates our programs there.

JOSEPH KASTELIC, Professor of Nutritional Biochemistry, Department of Animal Science, University of Illinois

MEETING THE PROBLEMS IN SIERRA LEONE

The most apparent need in Sierra Leone is to improve agricultural production. In reaching this goal, the people of the country, as well as specialists from the University of Illinois, face a number of clearly discernible problems.

Sierra Leone is a small country with a harsh climate and poor soil resources. Mineral resources include some diamonds, iron, bauxite, and rutile, but no known coal, oil, phosphate, lime, or potash deposits.

The country is not industrialized, it lacks capital resources for development projects, and it is isolated from world markets.

Educational facilities are inadequate and the population is largely illiterate. Political and social stability is problematical.

Model conditions for development

Other problems arise because reality falls short of the model conditions that should exist for successful agricultural development. Ideally, American personnel should be familiar with the soil and climate of the country to which they are assigned. They should also understand the social or cultural biases which might affect acceptance of new ideas or practices.

In the developing country itself, competent counterparts of American personnel are needed to assist in starting projects and to continue them after American specialists have left. The central government should encourage careful selection of development goals, support these goals, and generate realistic programs for their achievement. It should provide reasonable economic incentives and adequate market outlets to encourage farmers to increase production.

Farmers, agricultural workers, and extension specialists in the developing countries should have opportunities to learn about improved farming practices. And all citizens should be prepared to support national development goals.

Reality falls short of model

At first glance it would seem that the disparity between the model circumstances for development programs and the realities in Sierra Leone is so great that only frustration could result.

We must admit that a tremendous gap still exists between our knowledge of temperate zone agriculture and tropical agriculture. And we are not very familiar with the cultural and social systems of Sierra Leone.

We must also accept that Sierra Leone does not have many well-trained agricultural scientists and that most of its farmers are illiterate. The central government has not yet developed realistic long-range plans for agricultural development or seriously considered development priorities for the nation as a whole. Recent events indicate that the country faces a long hard pull in establishing a stable government.

What we can do now

The question remains then of what can be done under the existing circumstances. I believe that we need to formulate a manageable program based on the resources at our disposal. We need to decide how many University of Illinois staff members we can assign to Sierra Leone, how we can protect their professional interests, and how we can integrate their efforts with our on-campus research and teaching.

We should encourage students from Sierra Leone to do their thesis research on their own problems. And we should encourage our own students to go abroad for thesis research if they are interested in careers in foreign agriculture.

Projects to meet the requirements for graduate research need to be developed at Njala University College. We should probably concentrate on studies of soils and crops. We must not overlook, however, that the main food crop in Sierra Leone is rice and that another important food crop is the oil palm. Unfortunately, the staff at the University of Illinois is not trained to deal with these crops. This situation may be changed if rice and oil palm experts from other institutions provide technical assistance.

ROBERT J. WEBB, Assistant Director of the Agricultural Experiment Station, Dixon Springs Agricultural Research Center

Ideally, agronomic research in Sierra Leone would be an intensive, long-range program, requiring adequate financing and the organized participation of scientists in a number of subject-matter areas. If, however, we don't have the resources for such an approach, I believe that studies of soils and crops should receive first priority in allocating the resources that we do have.

We have the competence necessary to conduct such studies, particularly studies on forage crops. These crops are especially important in areas of marginal productivity.

Work on soils and crops is mandatory for future development of food production potentials in Sierra Leone. Results of soils studies are widely applicable to studies of crop production, whether these be on rice, the oil palm, maize, or forage crops.

Long-term planning of soils research, from area-by-area reconnaissance studies to more detailed soil analyses, will assure continuity of this work. At the same time soil research projects can be scaled up or down to conform with available resources. Unlike such large-scale projects as plantation development, soil research does not depend on government policy.

Participation in basic soil studies under environments different from our own would broaden our knowledge of soil science. Opportunities would be provided for thesis research by both Sierra Leonian and American graduate students.

As additional money and staff become available, other segments of agricultural research could be added to the soils studies, broadening and strengthening the educational program at Njala University College.

ILLINOIS ASSISTANCE PROGRAMS IN INDIA

The University of Illinois has given technical assistance to India under four contracts with U.S. government agencies.

Under the first contract, signed in 1952, the University provided assistance to the Allahabad Agricultural Institute. During the three years that this contract was in effect, seven Illinois technicians served two-year assignments at Allahabad.

Regional contract

A second contract, negotiated in 1955, and terminated in 1964, provided for assistance to eight colleges of agriculture and three colleges of veterinary medicine and animal science in Region I of India, comprising the states of Uttar Pradesh and Madhya Pradesh.

While this contract was in effect, Illinois technicians spent 50 man-years in India, 103 Indian staff members were brought to the United States for training, and Indian institutions received $300,000 worth of books and equipment.

As Dr. L. E. Card has said, "The real values are to be found in the area of intangibles. What ideas came out of the exchange relationships and were helpful to the Indians in improving their educational institutions? What lines of communication were set up so that a continuing exchange of educational ideas will take place? How much Indian culture and philosophy have we brought back to the local campus to help promote a better understanding of world problems? These important questions cannot be answered by statistics or evaluated in dollars."

Uttar Pradesh Agricultural University

While the regional contract was still in effect, the University Education Commission of India recommended the establishment of agricultural or rural universities in India. The Uttar Pradesh state government accepted this recommendation and asked the University of Illinois for help in planning an agricultural university. H. W. Hannah was assigned the task of preparing a "Blueprint for a Rural University in India," in cooperation with the U. P. State Director of Agriculture and other government officials. The 16,000-acre Tarai State Farm, near the village of Pant Nagar, was approved as the site of the new university.

Under a contract signed in 1959, the University of Illinois agreed to assist in establishing the U. P. Agricultural University. Since then, the University of Illinois has participated continuously by supplying advisers and consultants, providing training for Indian staff members, and purchasing books, equipment, and supplies. Both two-year and short-term advisers and consultants have worked on the contract.

Altogether, 28 staff members from the University of Illinois have served at U. P. Agricultural University and 37 Indian staff members have come to the United States for training.

The university now has about 1,500 undergraduate students, 200 graduate students, and 150 academic staff members. The university's extension program is having an impact on the surrounding area. The experiment station is well developed and has been asked by the state government to take over all agricultural research in the state. Support from the Rockefeller Foundation and Inter-Asian Corn Program has been most helpful to the experiment station.

The large university farm of more than 10,000 acres is devoting most of its facilities to the production of adapted hybrid seed corn and improved wheat varieties. A well-developed processing and distribution sys-

(Please turn to page 23.)

As we expand our overseas commitments for research and teaching, we need to broaden our knowledge of other societies and cultures

New Opportunities for Land-Grant Universities in a Hungry World

ORVILLE G. BENTLEY, Dean of the College of Agriculture, University of Illinois

As we move through the last half of the twentieth century, it is increasingly apparent that management of the world food problem depends upon strengthening education and research in food-deficit countries.

The American Land-Grant universities have the competencies and the leadership capability necessary to share U.S. agricultural know-how with less developed countries and to help these countries build their own teaching and research institutions.

Advance planning necessary

If this concept is to become an integral part of the colleges of agriculture, they must begin to plan now for implementation of overseas programs in the 1970's and 1980's. Effective planning necessitates consideration of these kinds of questions:

Do we as a staff want to become involved in international agriculture and use the involvement to broaden the scope and objectives of our own teaching and research programs? The question may be simple, but as yet it has not been fully answered. Obviously, however, the answer must come ultimately from both the faculty and the administration of the college.

Another question to consider is the possible effect of new international programs on the balance of research and educational programs. There is, for example, a growing interest in basic research. At the same time the need continues for applied research that will solve practical problems — the type of research that has been a hallmark of the Land-Grant university for many decades. Colleges of agriculture need strong programs of both basic and applied research that will attract the best scientific talent available. Will the "service" aspects of overseas activities detract from research aimed at meeting our overriding commitment to U.S. agriculture?

An exciting opportunity

Despite these complications, the colleges of agriculture have an exciting opportunity to demonstrate their relevance to a national commitment by assuming greater leadership in adapting American-style research and education to world-wide agricultural development.

The role of research in developing and maintaining the efficiency of U.S. agriculture is well accepted. But the relationship of research to the agricultural problems in less developed countries has not yet received adequate attention. It is becoming increasingly clear, however, that agricultural research is a forerunner of progress in increasing the productivity of traditional agriculture in the developing countries.

Broad perspectives needed

Staff members of colleges of agriculture will need more than technical competence and resources to carry out research. They will need to broaden their perspectives on the application of their research findings and the scope of their "laboratories" for doing the research. They will also want to become more knowledgeable about cultural, geographic, and social considerations having a potential impact on international agricultural programs.

The same sort of knowledge is of course necessary to conduct teaching and extension programs. One precept behind a successful extension program in the United States is that the staff know and understand the people who use the information being extended.

How can staff members acquire the detailed knowledge of an area that is necessary for successful programs? Again there is no simple answer. One possibility is to capitalize more effectively on the experience of staff members who have served overseas or who have otherwise gained knowledge of the people, institutions, culture, soil, and climate of possible target countries. Also, graduate students interested in international agricultural programs can be encouraged to take courses that will broaden their knowledge about the people of the world.

Addition of international dimensions to departmental programs must be reflected in decisions on staff selection for a particular area. Staff people will need to assess the long-term career opportunities open to

them in international activities. Frequently a question is raised about advancements and salaries for staff members either serving overseas or working on international programs. However, this need not be troublesome if there is administrative support for international activities.

Cooperative arrangements

Because of the scope of international agricultural programs, it will be expedient for colleges of agriculture to develop cooperative arrangements for serving overseas. Certainly graduate programs in other countries must be developed around centers where there are enough competent staff members to carry on effective research and extension programs.

Some overseas graduate programs might be facilitated by (1) a joint thesis advisory committee made up of faculty members from several U.S. universities working in a particular country; (2) use of qualified university staff members from the host country as part of the thesis committee; (3) arrangements between a U.S. university and a counterpart foreign institution whereby foreign graduate students can pursue part of their studies on their home campus and part in the United States.

We must give more recognition to the needs of foreign graduate students and not expect them to fit into the same mold as our own U.S. students.

To carry out more effective graduate training programs, technical assistance projects, and research, we may find it helpful to work cooperatively with other universities through consortia. Our university is a member of the Midwest Universities Consortium for International Affairs, the Committee on Institutional Cooperation, and the Council of U.S. Universities for Rural Development in India. Through these group efforts we can contribute effectively to international efforts that would not otherwise be possible, and still meet all our domestic responsibilities.

In closing, it seems apropos to quote from Senator George McGovern of South Dakota:

"If we are to be truly successful in promulgating and defending the democratic principles we hold so dear, we must strive to make men free from hunger as well as free from political intimidation.

"The United States cannot become the granary of the world. If the specter of famine is to be banished from the globe, the underdeveloped countries themselves must greatly expand their food production. To do this they need our help. If our pledges of assistance are to be kept and our continued domestic agricultural productivity assured, we must act now to provide the training necessary to insure an adequate supply of agricultural specialists in the demanding years ahead."

University of Illinois Efforts in International Programs *(Concluded)*

tem is getting this seed to cultivators in Uttar Pradesh and in some adjoining areas.

The vice-chancellor of U. P. Agricultural University, Dr. D. P. Singh, says that the university farm and neighboring Tarai farmers will soon be able to fill the entire state requirement for quality hybrid corn and wheat seed. He also says that Uttar Pradesh can produce 30 million extra tons of maize on the 10 million acres that lie fallow in the state during the rainy season. This increase, he maintains, would wipe out the food deficit of the country in a couple of years and convert Uttar Pradesh into a surplus state.

Jawaharlal Nehru Agricultural University

In 1964, six colleges of agriculture and two veterinary colleges in Madhya Pradesh were combined into the Jawaharlal Nehru Agricultural University. That same year the University of Illinois signed a contract to give advice and assistance to this new university.

In addition to a regular staff of administrative and professional advisers, the University of Illinois may assign up to three graduate students to work in India. Another change in the staffing pattern is an experiment to fill a two-year research adviser position with four or five staff members serving four-month periods in India in rotation.

Indian staff members who have received M.S. degrees at the University of Illinois and who have outstanding records are being returned to Illinois to prepare for their Ph.D. degrees. Some will return to India after about a year of study and complete their program at the Indian Agricultural Research Institute.

Substantial progress is being made at the Jawaharlal Nehru Agricultural University. However, travelers to both J.N.A.U. and U.P.A.U. have commented that it is easier to build a Land-Grant type university "from scratch" as in the case of U.P.A.U. than to bring existing institutions together, as at J.N.A.U.

Some general comments

Where a university is respected, it can develop and implement programs of teaching, research, and extension that will have a great impact in satisfying a country's food needs.

In India, the Land-Grant university concept enjoys general acceptance. I therefore believe that properly developed agricultural universities will be very effective.

The efforts of the University of Illinois in Indian agricultural programs have been rewarding to both countries. Results of these efforts will reveal themselves at an ever-increasing speed.

AT THE SYMPOSIUM . . .

Top right. Harvey J. Schweitzer, Associate Professor of Rural Sociology, was chairman of the committee that planned the symposium.

Right. During the symposium President Ralph E. Nowlan of the Federal Land Bank of St. Louis (center) presented gold medals "for outstanding contributions to American agriculture" to the College of Agriculture, to Director John B. Claar of the Cooperative Extension Service (left), and to Dean Orville G. Bentley (right). Congress and President Johnson authorized a limited number of these medals to commemorate the bank's fiftieth anniversary.

Lower right. A number of students and staff from other countries attended the symposium. Mrs. Krishna Chakrabarty of India is on the staff of the Department of Animal Science.

Below. Television interviews expanded the audience for the symposium speakers.

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Spring, 1968

ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Complete confinement rearing of lambs on slotted floors from birth to marketing has worked well at Dixon Springs (page 10).

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Illinois Agricultural Experiment Station

CONTENTS

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M. B. Russell . . . . Director

Margery E. Suhre . . Editor, ILLINOIS RESEARCH

Departmental representatives: Lowell Hill, Kent Mitchell, J. W. Pendleton, H. M. Scott, K. A. Kendall, Joseph Tobias, C. S. Walters, Jeanne Hafstrom, M. C. Carbonneau, David Gottlieb, P. D. Beamer.

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NEWS AND VIEWS

Basic Science in Agriculture

AGRICULTURE involves the interaction of physical and biological systems centering around soils, plants, and domestic animals in a complex social and economic environment. In seeking to understand and manage these interactions, we find it helpful to systematize our knowledge and to enunciate principles from which generalizations can be drawn. It is therefore axiomatic that basic sciences are essential to agriculture. Hence all students, practitioners, and scientists in agriculture should have as good a grasp of basic scientific principles as possible.

At this point we should perhaps state what we mean by "basic science." According to Webster, science is "any branch or department of systematized knowledge considered as a distinct field of investigation or object of study . . . concerned with observation and classification of facts especially with the establishment and the quantitative formulation of verifiable general laws, chiefly by induction and hypothesis." By basic science, then, we would mean those portions which underlie the systems comprising agriculture; these include in varying degree all the physical, biological, and social sciences, and most of the subsciences into which they are divided.

With the continued extension of knowledge in each field of science that impinges on agriculture, it is clear that no individual can achieve full mastery of all relevant scientific fields. We therefore need to assemble from the basic sciences a body of knowledge which is of maximum value in understanding agriculture or one of its subdivisions. Such subassemblies of knowledge then become agricultural science or one of its components such as soil science or dairy science. To be sure, the basic laws of the underlying sciences are an integral part of the new subassemblies, but additional principles applicable to the specific fields now emerge which give the "new" sciences their characteristic features and individuality.

The unique characteristic of agricultural sciences is their emphasis on interactions and on the resynthesis of knowledge from the several "basic" sciences. In this uniqueness lies our strength and our opportunity for major contributions to the scientific community and to humanity. — *M. B. Russell*

How Fertilizer Affects Field Drying of Corn

The primary purpose of fertilizing corn is to obtain the most profitable yield; but if nitrogen and phosphorus do increase yields, they may also have the important secondary effect of reducing grain moisture at harvest

L. F. WELCH and L. V. BOONE

Two wet falls in a row — 1966 and 1967 — have pointed up the problems that occur when corn grain dries slowly in the field.

If harvest is delayed because of slow drying, fall preparations for the following year's crop are also delayed. The grower may not have time to apply fertilizer and plow in the fall where these practices are desirable. Fall preparations are important, for they usually permit earlier planting, which, in turn, generally increases yields. The large acreage cultivated by many Illinois farmers intensifies the need for fall work after corn harvest.

Field losses become greater as corn harvest is delayed. Stalk rot increases with time, resulting in lodged corn that may be missed by the harvest machine. More ears drop from the stalk also. The likelihood of snow and ice accumulating on the stalks increases as the harvest season progresses. This additional weight knocks more stalks down. In addition, fields are more likely to be muddy late in the season, further delaying the harvest operation.

Corn with a high moisture content must be sold at a discount. If the corn is dried by the owner, the costs and time required for drying become greater as moisture content increases.

Many factors may influence the rate at which corn dries. Weather conditions are of course paramount, but management practices such as planting date and choice of variety also have an effect. One other factor is the use of fertilizer.

During the past three years, experiments have been conducted to assess the effects of fertilizer on moisture content of corn grain at harvest, as well as the effects on yield. To determine the individual effects of the three major nutrients, the application rates are varied for one nutrient while the other two nutrients are applied at a constant rate. When nitrogen is being tried at different rates, for example, phosphorus and potassium are added at a constant rate to all plots.

In the following discussion of the results, a range in moisture content at harvest is reported. Regardless of actual moisture content, however, all yields are given on the basis of 15.5 percent moisture.

Nitrogen

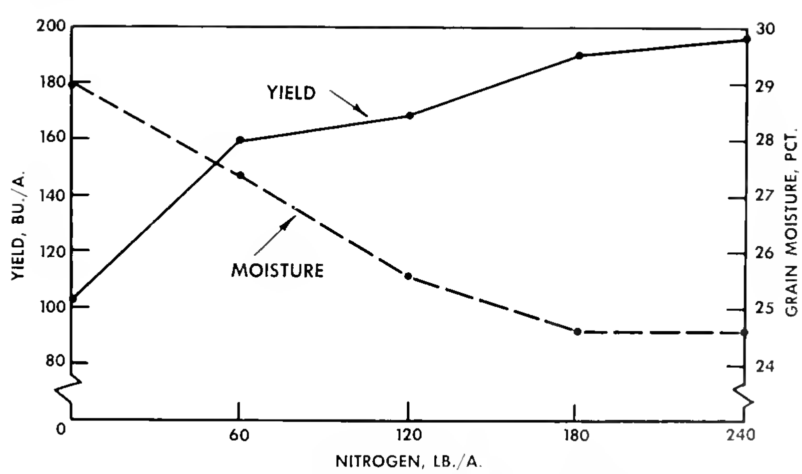
The lower leaves on nitrogen-deficient plants turn yellow and die much earlier than leaves on plants adequately supplied with nitrogen. This has often led to the conclusion that nitrogen delays maturity. In our experiments, however, nitrogen actually resulted in drier corn at harvest. At Kewanee Experiment Field, the 1966 yield without nitrogen additions was 104 bushels per acre and the grain contained 29 percent moisture (see chart). The addition of 180 pounds of nitrogen increased yields to 191 bushels per acre and reduced moisture content to 24.6 percent.

If this corn had been sold at prices prevailing in the fall of 1967, the corn grown with adequate nitrogen would have sold for about $0.13 per bushel more than the corn without nitrogen. When yield increase is considered as well, the added nitrogen greatly boosted the return per acre.

Results at the Toledo Experiment Field also show that nitrogen tends to hasten rather than to delay dry-

Table 1. — Effect of Nitrogen on Corn Yield and Grain Moisture, Toledo Experiment Field

Nitrogen, lb./A.	1965 Moisture, pct.	1965 Yield, bu./A.	1967 Moisture, pct.	1967 Yield, bu./A.
0	22.8	75	29.8	74
60	22.4	122	27.9	115
120	20.7	144	24.8	136
180	22.6	132	25.4	142
240	20.8	137	25.8	141



Effect of nitrogen on corn yield and grain moisture content, Kewanee, 1966.

L. F. Welch is Associate Professor of Soil Fertility; L. V. Boone, Associate Agronomist.

ing. As shown in Table 1, the application of 240 pounds of nitrogen reduced moisture content less in 1965 than in 1967. This was due to the better drying conditions in 1965. If the 1967 harvest at Toledo had been further delayed, the corn with no nitrogen would have dried faster during the delay period than the corn that had received heavy nitrogen applications.

The effect of fertilizer on grain drying is greatest in those years when we are not favored with good drying weather. Too, this effect will occur in years when we harvest early to minimize field losses.

Nitrogen apparently does not delay corn drying even when an excess of nitrogen is applied. In Table 2, for example, we see the effects of nitrogen additions on first-year corn following a legume. As the yields indicate, the 60-pound rate was adequate. At the higher rates, which were more than the plants needed, drying was not appreciably delayed.

Table 2. — Effect of More-Than-Adequate Nitrogen on Corn Yield and Moisture Content, Joe Bond Farm, Champaign County, 1967

Nitrogen, lb./A.	Moisture, pct.	Yield, bu./A.
0	28.1	161
60	27.2	170
120	27.7	166
180	28.1	169
240	28.1	161

Table 3. — Effect of Phosphorus on Corn Yield and Grain Moisture, Agronomy South Farm, Urbana

$P(P_2O_5)$ lb./A.[a]	1966 Moisture, pct.	1966 Yield, bu./A.	1967 Moisture, pct.	1967 Yield, bu./A.
0	31.8	99	35.4	93
18(40)	27.8	131	31.5	115
36(80)	27.0	141	29.7	123
54(120)	26.9	135	28.2	127
72(160)	26.5	139	28.0	134

[a] P_1 soil test was 5 pounds of P per acre on the O-P plot.

Table 4. — Effect of Phosphorus on Corn Yield and Grain Moisture, Dixon Springs, 1965

$P(P_2O_5)$ lb./A.[a]	Moisture, pct.	Yield, bu./A.
0	21.3	153
13(30)	20.8	162
26(60)	20.0	170
39(90)	19.9	168
52(120)	19.9	165

[a] P_1 soil test was 14 pounds of P per acre.

Phosphorus

Early in the season one can see the response of corn to additions of phosphorus on a phosphorus-deficient soil. Corn with adequate phosphorus grows faster and tassels sooner than phosphorus-deficient corn. The data in Table 3 indicate that the effects of phosphorus are reflected in the moisture content of grain at harvest.

The soil on which this experiment was conducted was very low in phosphorus, as indicated by the soil test and by the 40-bushel yield increase due to added phosphorus. Under this condition, phosphorus markedly decreased grain moisture.

The greatest yield increase (per pound of phosphorus) and the greatest reduction in moisture content occurred with the first rate of added phosphorus. This observation leads to the general conclusion that the greater the yield increase from added phosphorus, the greater the reduction in grain moisture at harvest. Where yield was affected little, moisture content was affected little.

This point is further emphasized by data from Dixon Springs (Table 4). The soil there had about 3 times as much soil-test phosphorus as the soil where the Urbana tests (Table 3) were conducted. As a result, phosphorus additions had much less effect on yield than at Urbana. Since moisture differences become smaller as the grain becomes drier, the differences in moisture content at Dixon Springs might have been greater if the corn had been harvested earlier.

Potassium

The effect of potassium on yield and percent moisture can be seen in Tables 5 and 6. The studies reported in these tables covered a wide range of soil-test potassium, yield, and moisture content. The effect of potassium on moisture content ranged from no effect at Carlinville to an increase of 4.6 percentage points at Brownstown. Considering all data, the tendency was for added potassium to slightly increase moisture content.

Table 5. — Effect of Potassium on Corn Yield and Grain Moisture, Four Experiment Fields, 1967

$K(K_2O)$ lb./A.[a]	Moisture, pct.	Yield, bu./A.	Moisture, pct.	Yield, bu./A.
	Oblong		**Toledo**	
0	22.6	96	22.1	74
33(40)	23.9	149	23.6	140
66(80)	24.0	144	24.8	136
99(120)	23.2	149	26.4	138
	Carlinville		**Brownstown**	
0	22.4	74	24.9	40
33(40)	23.6	131	27.6	92
66(80)	22.7	147	28.1	103
99(120)	22.4	141	31.2	105
132(160)	22.4	139	29.5	99

[a] Soil test K on the O-K plot was 102, 86, 160, and 103 pounds per acre for Oblong, Toledo, Carlinville, and Brownstown, respectively.

Table 6. — Effect of Potassium on Corn Yield and Grain Moisture, Joe Bond Farm, Champaign County, 1967

$K(K_2O)$, lb./A.[a]	Moisture, pct.	Yield, bu./A.
0	26.5	148
50(60)	27.1	160
100(120)	27.7	164
200(240)	27.4	164
400(480)	28.2	164

[a] Soil test was 226 pounds of K per acre.

This tendency may be an indirect effect rather than a direct effect on physiological maturity. Low potassium causes early death of plant tissue, allowing stalk rot to kill the plant prematurely. This early death in turn hastens drying. Stalk rot was especially severe where potassium was deficient at Brownstown (Table 5).

High potassium increases resistance to stalk rot. Thus adding potassium to potassium-deficient soils may delay corn drying by postponing plant death. Adding more potassium than is necessary to remove the deficiency and maximize yields, apparently does not further increase the plant's resistance to stalk rot.

Allowable Loads for Anchor Bolts in Concrete

LARRY D. NAGRESKI and J. O. CURTIS

Buildings are normally held to their foundation by some sort of bolt or anchor that is embedded in the concrete of the foundation. This prevents high winds and other loads from moving the building.

Anchorages generally are subject to two types of loads. A load that pulls the bolt vertically away from the surface of the foundation is a *tensile load*. A load that is perpendicular to the bolt is a *shear load*.

To do an effective job of designing anchorage systems, one must know the strength of the bolt when subject to tensile and shear loads. The strength of the connection between the bolt and the concrete must also be known.

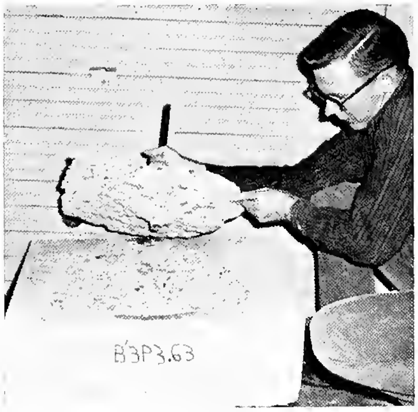
Reliable and widely accepted information is available on the strength of the bolt itself, but information on the strength of the connection between the bolt and the concrete is sketchy. As a result, there is wide variation in present recommendations on how deep to embed various sizes of bolts in concrete.

To supply more information on this subject, the Department of Agricultural Engineering has recently conducted an experiment to establish safe allowable loads for anchor bolts of various diameters under various conditions of embedment in concrete. Three common diameters of steel bolts were used — ½ inch, ⅝ inch, and ¾ inch.

Concrete specimens with the embedded bolts were load-tested until the connection failed. One series of tests was conducted with tensile loads; and another with shear loads.

The size of bolts does not influence the strength of the connection between bolt and concrete. However, the bolt must be able to withstand as much of a load as the connection.

Larry D. Nagreski was formerly an Assistant and J. O. Curtis is Associate Professor, both in Agricultural Engineering.



A connection failure. (Fig. 1)

Otherwise, the bolt will break before the connection fails. The maximum safe strengths of the three sizes of bolts are shown in Figure 2 by short horizontal lines. Thus, according to Figure 2, ½-inch bolts will support loads up to about 3,300 pounds.

Tensile-load tests

In the tensile or pull-out tests bolts were embedded in the concrete at depths of 1, 2, 3, and 4 inches. Recommended safe allowable pull-out loads for bolts embedded at these depths are shown in Figure 2.

A safety factor of two was used in formulating the safe allowable load recommendations. This means the allowable loads shown in Figure 2 are actually half of the failure loads found in the tests. The loads recommended in Figure 2 apply only when there is at least as much concrete all the way around the bolt as the depth of placement. When there is less concrete around the bolt, the allowable loads should be reduced somewhat.

Shear-load tests

In the shear tests bolts were embedded to depths of 2, 3, 4, and 5 inches. Bolts were also placed at either 2 or 3 inches from the edge of the concrete toward which the load pulled. In most buildings anchor bolts are placed 2 or 3 inches from the edge of the foundation.

Allowable shear loads are recommended in Figure 3 for various depths of bolt embedment and for bolts 2 and 3 inches from the edge of the concrete. These allowable loads are based on a safety factor of two.

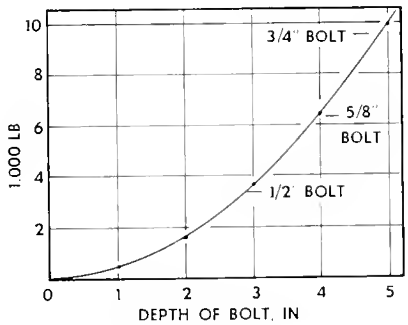
Effects of bolt spacing

The effect of bolt spacing on allowable load was studied in a limited way.

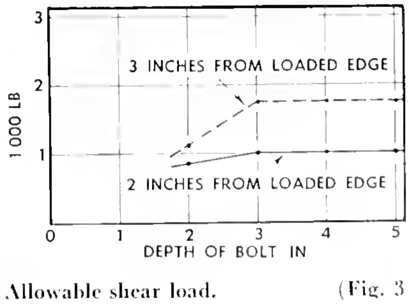
The minimum spacings listed below are recommended for various bolt embedments.

Embedment	*Spacing*
2 in.	9 in.
3 in.	13.5 in.
4 in.	17.75 in.
5 in.	22.25 in.

Use of these spacings will not reduce the average allowable load on each bolt.



Allowable tensile load. (Fig. 2)



Allowable shear load. (Fig. 3)

Band vs. Broadcast Fertilizer Applications

W. M. WALKER
and L. F. WELCH

Banding phosphorus and potassium often gives better corn yields than broadcast applications, particularly on soils testing low in these elements

No one method of applying fertilizer to corn is "best" for all conditions, but recent Department of Agronomy research indicates that row placement (banding) of phosphorus and potassium is more efficient under some conditions than broadcast applications.

Results of this research may help farmers find methods of fertilization for their particular farming situation that will increase the financial return per pound of applied fertilizer.

Phosphorus experiments

Phosphorus (P) was both banded and broadcast on three different soils to measure the effects on corn yields. Banded phosphorus was applied 2 inches to the side and 2 inches below the seed at planting, and broadcast applications were applied on the surface in early spring and plowed under. Four levels of phosphorus were applied by each method and by various combinations of the two methods. The soil types were Zanesville, Elliott, and Muscatine silt loams with P_1 tests of 5, 18, and 16 pounds per acre, respectively.

Nitrogen was broadcast and plowed under at a rate of 120 pounds per acre on the Elliott and Muscatine soils. On the Zanesville soil, 100 pounds of nitrogen were broadcast and plowed under, and an additional 100 pounds were side-dressed. Potassium was broadcast and plowed under at a rate of 100 pounds per acre (120 pounds of K_2O).

Corn yields increased with the application of phosphorus fertilizer on all three soils (Fig. 1). Yields were relatively low on the Zanesville soil because of drouth, but there was a significant response to phosphorus.

On both the Elliott and Zanesville soils, greater yield increases resulted from banding phosphorus than from broadcasting, regardless of application rate. The largest yield difference due to application method was found on the Elliott soil.

Although the P_1 tests for the plow layers of Elliott and Muscatine soils were similar, the response to applied phosphorus was less on Muscatine than on Elliott. This was probably due to a higher level of available phosphorus below the plow layer of the Muscatine soil. Along with the decreased response to applied phosphorus on Muscatine, differences due to method of application were also less than on the other soils.

Table 1 presents yield differences due to application method for three rates of phosphorus. On both the Elliott and Zanesville soils, the largest differences due to method were at the 20-pound-per-acre rate (46 pounds of P_2O_5).

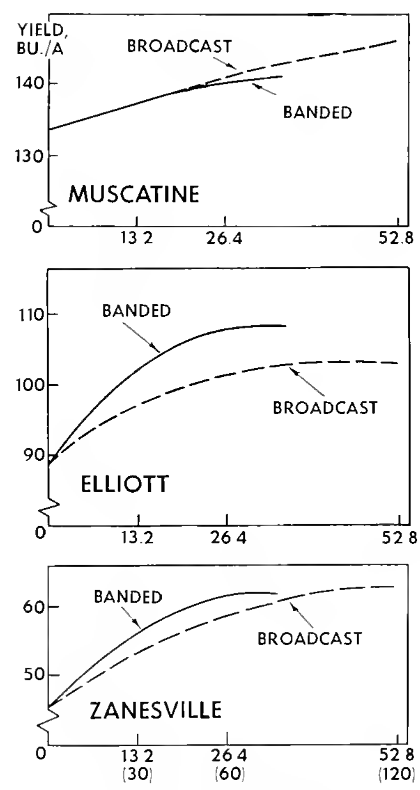
Potassium experiments

Potassium (K) was both banded and broadcast on three different soils over a three-year-period to determine the effects on corn yields. Four levels of potassium were applied by each method and by various combinations of the two methods. Soils used in the tests were Cisne, Bluford, and Belknap silt loams with potassium soil tests of 56, 144, and 148 pounds respectively.

Phosphorus was broadcast at a rate of 22 pounds per acre (50 pounds of P_2O_5) on Cisne and Bluford soils, and at 51 pounds per acre (116 pounds of P_2O_5) on the Belknap soil.

Nitrogen was broadcast at 100 pounds per acre on the Cisne and Bluford soils, and at 120 pounds on the Belknap. In addition, relatively small amounts of nitrogen and phosphorus were banded at planting time.

Application of potassium fertilizer increased yields on all three soils (Fig. 2). Yield increases were largest on Bluford and Cisne soils. On both these soils the largest increases came at the lower rates of application. All



Response of corn to banded and broadcast phosphorus on three soils. (Fig. 1)

W. M. Walker is Assistant Professor of Agronomy and L. F. Welch is Associate Professor of Soil Fertility.

three soils gave higher yields from banding than from broadcasting.

Differences between yields produced by the two methods of application are shown in Table 2. The largest differences were on the Cisne soil at the 32-pound-per-acre rate (38 pounds of K_2O).

Banding usually most efficient

According to these results, band applications of phosphorus and potassium can usually be expected to produce higher yields than broadcast applications of the same amount when all other factors are constant. This is especially true at the lower application rates.

In general, the lower the test level of a soil, the larger the difference in yield between banded and broadcast fertilizers. The potassium test level of Cisne, for example, was 56 pounds per acre, compared with 144 and 148 pounds for Bluford and Belknap. The difference in response to method of applying potassium was much greater on Cisne than on the other two soils.

The nutrient level below the plow layer may modify the effects of application method. The higher the nutrient level below the plow layer, the lower the response to applied fertilizer and the lower the differences due to application method. As already mentioned, a high level of phosphorus below the plow layer of Muscatine probably limited the response to phosphorus fertilizer on that soil.

If heavy applications of fertilizer are to be made, banding may present hazards. Although the small amount of fertilizer used in "pop-up" applications would not be expected to affect plant populations, larger amounts of fertilizer placed in contact with the seed may retard germination. Care should therefore be taken to place the fertilizer away from the seed. Many studies show that placement to the side and below the seed is best for corn.

Band plus broadcast applications

It may be impractical to try to apply all needed fertilizers in a band

Table 1. — Yield Differences Between Band and Broadcast Phosphorus on Three Soils at Three Rates[a]

$P(P_2O_5)$, lb./A.	Yield difference, bu./A. Zanesville	Elliott	Muscatine
10(23)	2	5	0
20(46)	4	7	0
30(69)	2	6	−1

[a] Yield difference equals yield from row application minus yield from broadcast applications.

Table 2. — Yield Differences Between Band and Broadcast Potassium on Three Soils at Three Rates[a]

$K(K_2O)$, lb./A.	Yield difference, bu./A. Belknap	Bluford	Cisne
16(19)	0	8	18
32(38)	1	11	20
48(57)	4	13	17

[a] Yield difference equals yield from row application minus yield from broadcast applications.

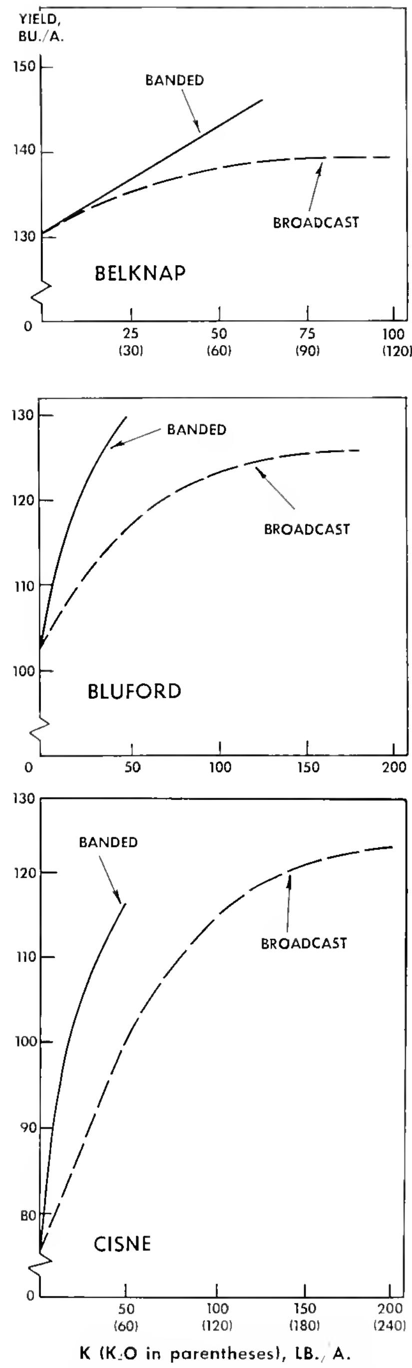
on soils with low fertility. If a long-term goal is a build-up of soil fertility, then some portion of phosphorus and potassium fertilizers should be broadcast.

In addition to being practical, a combination of methods may actually increase yields if large amounts of fertilizer are to be applied. Data not included here indicate that when 35 pounds of phosphorus per acre (80 pounds of P_2O_5) were applied to Zanesville and Elliott soils, the highest yield resulted from banding 60 percent of the phosphorus and broadcasting 40 percent.

Flexibility in timing of applications sometimes makes broadcasting the preferred method for applying part, or even all, of the fertilizer. Banding must be done at planting time, but broadcast applications can be made at many different times of the year.

Cost of application methods

Finally, cost is an important consideration in choosing an application method. If you already have band equipment, this method will often give a higher cash return in relation to your expenses than will the use of



Response of corn to banded and broadcast potassium on three soils. (Fig. 2)

broadcasting equipment. But if you have to buy new band equipment, it might be more economical to rely entirely on broadcast placement. This is especially true for tenant farmers who have to bear all the cost of new machinery but must divide any yield increases with their landlords.

Meat Scientists Seek Improved Meat Quality

Among the problems being studied: Why will two similar animals vary widely in the amount of edible meat they yield? And why is there a low correlation between the marbling and external finish of an animal?

JOHN R. ROMANS, A. H. SAFANIE, and ROGER BALL

Annual per capita consumption of meat in the United States is now estimated at 176 pounds, including 106 pounds of beef, 63 pounds of pork, 3½ pounds of veal, and 3½ pounds of lamb. A large proportion of this meat is produced on Illinois farms. During recent years about 45 percent of the cash farm income in the state has come from sales of meat animals and their products. It is therefore evident that red meat is important to Illinois from both the production and the consumption viewpoints.

Much has been written in recent years about the relative efficiency of animals and plants in producing proteins for human consumption. It is generally agreed that crop production should receive top priority in underdeveloped or overpopulated countries. Yet, as societies become more highly developed and affluent, consumption of red meat and emphasis on its efficient production usually increase markedly. In Japan, for example, consumption of red meat has doubled in recent years.

Animal scientists in highly developed countries such as ours are concerned with research in ruminant and non-ruminant nutrition, nutritional biochemistry, endocrinology, physiology of reproduction, population genetics, immunogenetics, and ecology, with the broad objective being to develop animals which are more efficient producers of meat. Each of these areas of research can become so complex that at times the final product — that is, the meat we eat — is all but forgotten. It is the place of the meat technologists, or meat scientists (a more accurate term in our opinion) to be directly concerned with this end product.

John R. Romans is Assistant Professor of Animal Science; A. H. Safanie, Assistant Professor of Veterinary Anatomy and Histology; and Roger Ball, Research Assistant in Animal Science.

Variation of carcass composition

One problem being studied by the meat scientists is the variation in carcass composition. Two 1,000-pound beef animals within the USDA Choice grade, for example, can vary as much as 90 pounds (from 300 to 390 pounds) in the amount of edible meat they yield. The reason for this great disparity is the relative amounts of fat and muscle (lean or protein) in the two animals, since bone does not vary appreciably in mature animals.

At one time, the only method of determining the composition of such animals was to slaughter them and cut the carcasses to obtain the actual measurements. But in recent years tools have become available to estimate body composition in the live animal quite accurately. Here at Illinois, we are using Illasco, which monitors the relatively constant amount of radioactive potassium (K^{40}) in lean tissue (*Illinois Research,* Winter, 1965).

Current research endeavors in meat science are drawing us ever closer to the disciplines of biochemistry and physiology. We still need certain physical measures of carcass composition to maintain a system of checks and balances, and will therefore continue to slaughter some animals and evaluate their carcasses as in the past. But the main emphasis now is on why body composition changes.

Lipid metabolism is important

The area of lipid (fat) metabolism is of great importance in terms of ultimate body composition and is one of our "why" types of meat research.

Consumers generally prefer retail meat cuts with an external (subcutaneous) fat cover about ¼ inch thick. Most meat animals which are properly finished for a quality grade of U.S. Choice have more than this amount of subcutaneous fat, so somewhere in the processing procedure the extra fat must be removed.

On the other hand, a generous amount of intramuscular fat (marbling) is preferred for optimum palatability of steaks and roasts. Strangely enough, the correlation between amounts of subcutaneous fat and intramuscular fat is quite low. Although we can physically remove the excess subcutaneous fat, there is no way to physically add intramuscular fat.

For many years animals have been fattened on properly balanced rations high in carbohydrates. The metabolic pathways by which carbohydrates are converted to fats in the animal's body are well known. Body fats themselves are in a state of almost constant flux between those forms immediately available for energy (free fatty acids) and those present in the body as stored energy (triglycerides).

No work has been done, however, showing the relative availability for energy of the subcutaneous depot fats and of the intramuscular fats. If those triglycerides stored in the intramuscular depots are more readily converted to free fatty acids and thence to energy than are those of the subcutaneous fat, we would have a possible explanation for the lack of marbling in certain well-finished animals and the low correlations between marbling and external finish.

An initial biopsy sample is removed from the ***longissimus dorsi*** (loin) muscle before the animal is subjected to a period of stress. (Fig. 1)

Stress consists of fasting for 30 hours before slaughter and exercising at about 2.5 miles per hour during alternate hours, beginning 12 hours before slaughter. (Fig. 2)

To check the movement of body fats, hourly blood samples are taken through an indwelling jugular catheter during the exercise period. (Fig. 3)

The total fat, or lipid, in the muscle and plasma samples is separated into its five main classes by means of thin-layer chromatography. (Fig. 4)

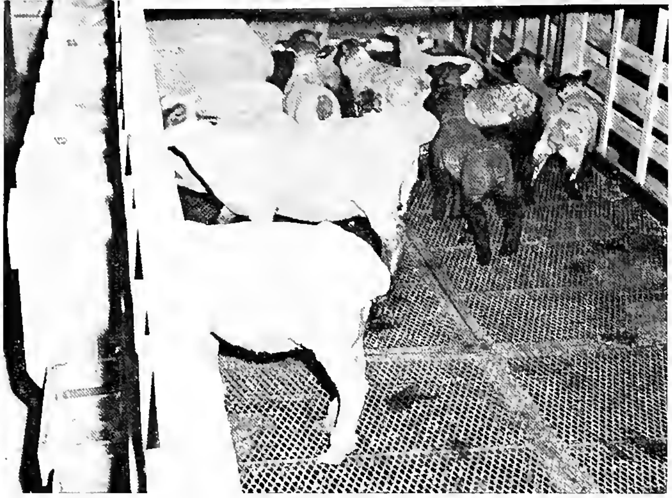
Research on fat mobility

To test this hypothesis, we secured a biopsy muscle sample from the *longissimus dorsi* (loin) of the left side of an animal (Fig. 1). The animal was then put through a series of stresses requiring energy expenditure (Fig. 2), during which time blood samples were taken hourly (Fig. 3). After the stress period, the animal was slaughtered and another muscle sample taken, this time from the right *longissimus dorsi*. Since bilateral symmetry has been proven previously, any differences in the fat content of these two samples, correlated with the blood picture during the stress period, should give us an accurate indication of the mobility of the intramuscular fats.

Tissue and blood samples from 10 animals treated in this way are being qualitatively and quantitatively analyzed in our laboratory. Thin-layer chromatography is being used to separate the total lipid (fat) into its five main classes, namely phospholipids, cholesterol, free fatty acids, triglycerides, and cholesteryl esters (Fig. 4). Tissues are also being examined histologically to determine possible changes in lipid content.

Pilot work done earlier with rabbits has indicated that the intramuscular lipids are not more mobile than the subcutaneous depot fats. However, we will not apply these results to cattle at this time, but will wait for the laboratory analyses to be completed.

Future research endeavors will include efforts to determine why certain animals deposit fat within their muscles and others do not. Biochemical assays for the enzymes involved in synthesizing and mobilizing lipids will be one avenue of approach. In a broad sense, we can say that future meat research at Illinois will be concerned with learning more about that amazing meat factory which nature began putting together many centuries ago and which we are just beginning to really understand.



Feeders and waterers hanging outside the pens permit full use of floor space. Adjoining floors are used as a creep feeding area.

Floors were built as 4- by 8-foot units with steel or wood frames set 2 feet off the ground on angle-iron legs. Placed side by side, the units made pens of varying sizes.

Slotted Floors Are Practical for Lambs

L. A. AREHART, J. M. LEWIS, and H. A. CATE

Twenty lambs nearing market weight appear crowded on 80 square feet of slotted floor, but they performed as well as lambs with 2 to 3 times as much space. Native, early-weaned lambs made these average daily gains with different amounts of floor space: 4 square feet, 0.65 pound; 6 square feet, 0.64 pound; 8 square feet, 0.68 pound; 10 square feet, 0.69 pound.

As sheep producers turn to accelerated lambing, early weaning, and confinement rearing systems, slotted floors become increasingly practical. Compared to on-the-ground or pasture systems of lamb management, slotted-floor systems require less labor and reduce space and housing requirements. Slotted floors also control or even eliminate internal parasites, eliminate bedding costs, and contribute to lamb comfort in hot weather.

Several types of materials may be used for slotted floors. Five have been tried at the Dixon Springs Agricultural Center. They are wood, concrete, steel grids, flattened expanded metal X-plate, and Safe-T-Mesh expanded metal.

Ewes were placed on floors before lambing and removed to pasture when lambs reached 6 weeks of age. Lambs were continued on the floors until marketed. Space allowance for each ewe and her lambs on the floor was 12 to 16 square feet. (Alternative systems permit the ewes to lamb on the ground and then either be moved with their lambs to the slotted floors, or remain with their lambs on ground until the lambs are weaned at 6 weeks and placed on slotted floors.)

Complete confinement of lambs on slotted floors from birth to marketing worked well. Lambs gained equally well with similar feed requirements on all five test floors. Internal parasites were completely controlled on all floors without the use of drenches.

The expanded metal X-plate, wood, and concrete slats made the best self-cleaning floors. Manure tended to freeze and build up on the steel grid floors. Fleeces became more manure-stained on the concrete slats and the steel grids than on the other floors, probably because these two materials had a greater solid surface area relative to the openings.

Sheep were more sure-footed and hooves wore more evenly on the expanded metal X-plate and the Safe-T-Mesh metal than on the other floor materials.

Humid weather increased the sheep's tendency to slip on the steel grid floors, especially when they moved rapidly in the direction of the long axis of the grids.

Very young lambs often caught one or more feet in the irregular openings of the wood floors and required help in freeing themselves. The wood slats were acceptable for older lambs. Rough oak timber was used to make the wood floors for the test. A more satisfactory wood slat with an even surface and with less tendency to warp could be made from planed and seasoned lumber.

A few lambs on all the floors developed swollen knee joints, but this did not seem to affect the lambs' performance.

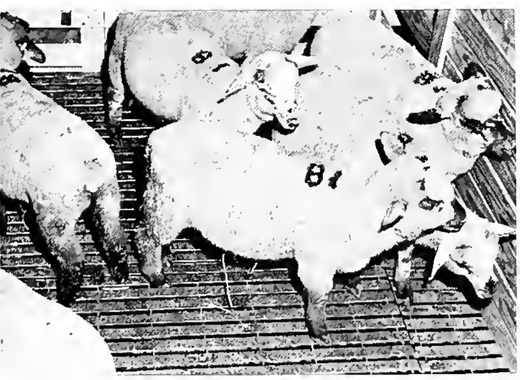
Injuries to the udders were not a problem among ewes with normal udder conformation. Abnormally large and pendulous udders, however, were subject to injury and mastitis.

Since all five floor materials gave good results, choice of material would depend upon the design of the existing facilities and the cost and availability of the different materials.

L. A. Arehart is Assistant Animal Scientist; J. M. Lewis, Associate Professor of Animal Science; and H. A. Cate, Associate Professor and Communication Specialist, Dixon Springs Agricultural Center. A. J. Muehling, Assistant Professor of Agricultural Engineering, Urbana, furnished some of the materials and the forms for the concrete slats.

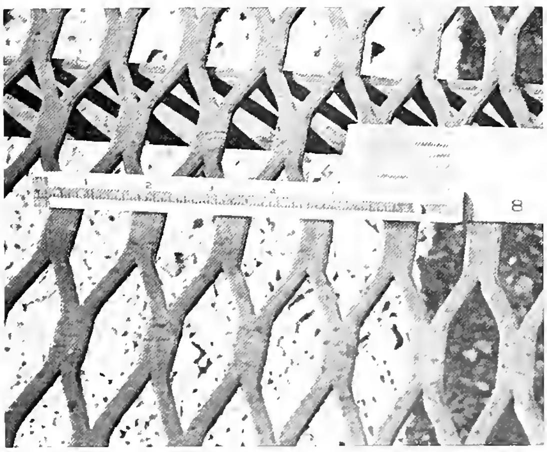
ch 4- by 4-inch rough oak timber furnished stock · two slats. A single, diagonal cut made slats out 2¾ inches wide (top face) and 1 inch wide ottom face). Wedge-shaped spacers, 2 inches ng, were sawed from the slats and gave spacings hich varied from ¾ to 1½ inches. Each slat was eet long.

ung lambs had some difficulty walking on the even wood slats. The openings varied in width cause the rough, undressed lumber made spacers irregular sizes. Also, the green lumber warped a degree. Older lambs and ewes had no problems walking on the wood slats.

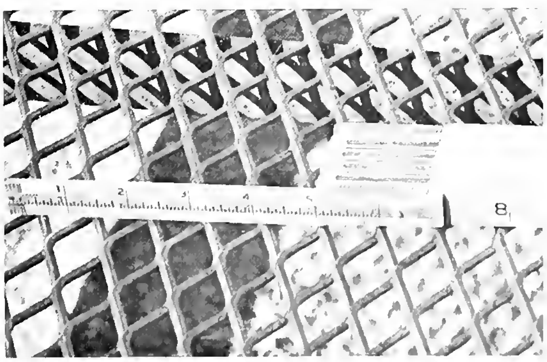


eel grid floors were made of steel slats, 1½ inches de, spaced with ⅝-inch openings on frames made 2- by 6-inch treated wood. These floors cleaned ss well than the other types of floors, but lamb rformance was satisfactory.

Concrete slats were 8 feet long, with the top faces 3 inches wide and the bottom faces, 1½ inches wide. The slats were reinforced with ¼-inch and ½-inch rods, and had an average weight of 65 pounds. To form a slotted floor, slats were spaced about 1 inch apart on a steel angle-iron frame. Slightly rounded slat edges allowed the droppings to work through the openings more easily than they would have otherwise.



Flattened, expanded metal X-plate in 4- by 8-foot sheets, cross-supported with steel bars, were set on 2- by 6-inch treated lumber frames with angle-iron legs. These floors cleaned well and kept the hooves of the sheep well trimmed.



Safe-T-Mesh floors were made from 4- by 8-foot sheets of ¾-inch mesh. The metal kept the sheep's feet well trimmed.

Transmissible Gastroenteritis of Swine

MIODRAG RISTIC

A pig-origin purified virus vaccine helps to control this serious malady of baby pigs

Outbreaks of transmissible gastroenteritis (TGE) have been prevented on several Illinois farms by means of a new vaccine developed in the College of Veterinary Medicine.

First described in 1946, TGE is the most serious malady of baby pigs in the major swine-raising areas of the United States. It is an acute, viral disease characterized by vomiting, profuse diarrhea, and dehydration. It affects pigs of all ages, producing up to 100 percent mortality among pigs less than 1 week old.

The new vaccine is a purified pig-origin virus vaccine. Its development was preceded by extensive research, both here and elsewhere, on the virus, mode of infection, diagnosis, and various methods of control.

Doyle and Hutchings (who described the disease in 1946) concluded that the causal agent was a virus, since they could produce TGE in susceptible pigs by using bacteria-free filtrates of infected pig tissues. This conclusion has been confirmed by a number of other scientists, who have used viruses propagated in tissue cell cultures to produce TGE in baby pigs.

Investigators at various institutions have made electron microscopic stuies of the virus grown in tissue and in baby pigs. Filtration studies have also been made with the virus from tissue culture. On the basis of these investigations, it has been concluded that the virus is 70 to 90 millimicrons in diameter (0.00000273 to 0.00000351 inch).

How infection occurs

The usual route of infection is through the mouth. The virus does not replicate in the stomach, but does grow in all segments of the small intestine. Growth is less pronounced in the ileum than in the duodenum and jejunum.

Within 4 hours after pigs are exposed to the virus, it invades epithelial cells in the lining of the small intestine, growing and replicating in the cytoplasm of these cells. The viral invasion causes the intestinal lining to slough villi, which are responsible for nutrient absorption. Impairment of nutrient absorption in turn leads to the clinical characteristics of the disease.

Diagnosis

In the field, TGE is most readily diagnosed on the basis of the clinical signs of the disease. Diagnoses can be confirmed by microscopic examination at low magnification of small intestinal mucosa from 3- to 5-day-old pigs. In cases of TGE, the small intestinal villi are usually partly or completely destroyed. Serologic diagnoses can be made by detection and titration of neutralizing and plaque-reducing antibodies in sera from affected sows.

Bentonite agglutination (BA) and bentonite agglutination inhibition (BAI) tests have been used to diagnose TGE in sows and baby pigs, respectively. When used singly, neither method has proved absolutely accurate under all circumstances.

Immunity depends on sow

Immunity and resistance to TGE in the principal host, the 1- to 7-day-old pig, seem to depend solely on the immunity of the nursing sow. Protection is conferred on the baby pigs by way of an antibody in the sow's colostrum and milk. For a baby pig to be protected from a fatal infection with TGE, it must continue to nurse on an immune sow or must be continuously fed milk or blood serum from such a sow. The continuous feeding impairs the growth of the virus in the piglet's intestines.

This type of immunity is known as "lactogenic local tissue immunity." It is clearly distinguished from the passive colostral type of immunity, which is the more typical way that maternal immunity is transferred to newborn pigs.

Like other viral diseases, TGE can best be controlled by developing immune responses in individual pigs and thus increasing resistance in a swine population. Since baby pigs are the principal targets of TGE, and since they do not usually develop active immunity, all research efforts have been directed toward stimulating immunity in sows, with the expectation that they, in turn, would confer immunity on their piglets.

If a sow is to have enough immunity to protect both herself and her piglets against TGE, she should have local intestinal immunity as well as systemic blood serum immunity. Sows that have local intestinal immunity usually have a variable degree of systemic blood serum immunity as well. In the latter type of immunity, the blood serum contains neutralizing antibodies which, after farrowing, are usually secreted into the milk.

Tissue culture vaccines

Different preparations of TGE virus propagated in tissue cultures were used in efforts to stimulate enough immunity in pregnant sows that they could protect their piglets against TGE. When sows were fed or inoculated with tissue cultures containing virulent TGE virus, a reasonable degree of protection was noted in their piglets on experimental challenge (that is, the pigs were given lethal doses of the TGE virus).

When the virulence of the virus

Miodrag Ristic is Professor of Veterinary Pathology and Hygiene and of Veterinary Research, and Senior Staff Member, Center for Zoonoses Research.

was attenuated through serial passages *in vitro,* the virus seemed to completely lose its immunogenic potency. Sows fed or inoculated with such a preparation did not seem to afford any protection against TGE to their piglets. Before the mechanism of this phenomenon can be intelligently investigated, a simple question awaits an answer: Do these "attenuated" tissue cultures still truly contain typical TGE virus, or is our evidence only presumptive?

Although inoculation of pregnant sows with the virulent tissue-culture-propagated virus can protect their piglets against TGE, this protection is not effective under all circumstances in the field. TGE outbreaks frequently start among feeder pigs rather than among pregnant or recently farrowed sows. The infection apparently spreads very rapidly among feeder pigs, with the virus gaining tremendously in virulence. Under this circumstance, sows which normally appear to be relatively immune to the disease, do not seem able to protect their piglets.

Gut tissue vaccines

As a means of immunization against TGE, swine producers often feed homogenates of the intestines of diseased baby pigs to pregnant sows. While this method appears to be effective, it has several drawbacks which caution against its use. The most important disadvantage is that infection with TGE virus seldom occurs in the field by itself. It is usually followed by and complicated with a series of bacterial and other infections, which often cause more severe and damaging effects than a single TGE infection.

There also seems to be interference with the proper growth and development of the TGE virus in sows fed such gut homogenates, probably because the diseased pig gut being fed usually contains a mixture of various microbes such as bacteria, mycoplasmas, and viruses. For example, we fed diseased gut homogenates to two sows and, on challenge, found that they saved only 65 percent of their piglets. It appears that the development of adequate protection against TGE requires the uninterrupted, vigorous growth of the virus. This was one reason that we undertook the development of the purified pig-origin TGE virus vaccine.

Pig-origin purified virus vaccine

Some three years ago, we used a modification of the density-gradient-centrifugation technique to isolate and purify TGE virus from the intestinal contents of infected baby pigs. Infectivity assays of individual fractions showed that most of the total infectivity was located in a distinct fraction. Electron microscopic studies of this fraction revealed the presence of one type of virus.

While our original purpose was to isolate and identify the TGE virus, we also tried immunizing pregnant sows with the purified virus. A suspension of the virus was poured into ½-ounce gelatin capsules and frozen at $-75°$ C. until used. Capsules were administered orally by means of a specially designed balling gun.

Sows receiving one capsule at least 10 days (preferably 21 days) before farrowing developed enough immunity to protect their 3-day-old piglets against challenge with 1,000 lethal doses of TGE virus.

The method was tested on four farms in cooperation with several practicing veterinarians and swine producers. On two of the farms, where TGE outbreaks had already occurred, the pig-origin vaccine effectively stopped further outbreaks. On the other two farms, which adjoined farms with active TGE infections, the method apparently prevented a possible TGE attack. Immunity to TGE was proven to exist in capsule-fed sows by challenging litters from four sows on these farms.

More recently we fed a capsule to a susceptible, pregnant, second-generation SPF (specific pathogen-free) sow 1 month before farrowing. A similar sow was used as an untreated control. Each sow was kept in a separate isolation unit. Droppings from the treated sow were collected twice a week during the prefarrowing period and for three weeks thereafter. These samples were kept frozen at $-75°$ C.

After farrowing, each piglet from each sow was given 1,000 lethal doses of TGE virus orally. No signs of TGE occurred among the eight piglets of the sow receiving the capsule. However, nine of the ten piglets from the untreated sow died of TGE and the sow also developed severe signs of the disease.

Droppings collected from the treated sow during the first 2 weeks after administration of the capsule were freed of heavy corpuscular material by centrifugation at $9{,}000 \times g$ (gravity) for 30 minutes. They were then fed to 3-day-old susceptible piglets kept in individual Horsfall-Bauer units. None of the piglets developed signs of TGE, which would indicate that the samples did not contain TGE virus pathogenic for baby pigs. The experiment is being continued to determine the extent of the period, if any, during which the TGE virus is shed in the feces of sows which received the capsule.

The capsules containing the purified virus have at least two advantages over the gut tissue vaccines: (1) The capsule contains apparently pure TGE virus free of other pathogens that complicate the disease. (2) The use of concentrated virus in capsules insures that each sow will promptly receive enough virus to stimulate the rapid development of immune responses.

At present it appears that the encapsulated vaccine will control TGE on farms where there have been outbreaks of TGE or on farms endangered by the presence of the disease on a neighboring farm. The vaccine should be used, however, under the supervision of practicing veterinarians and with the permission of state authorities.

It is apparent that research into the development of safer and more effective vaccines for prevention of TGE must continue. In the meantime, several methods can be used, singly or in combination, depending on particular circumstances, to safeguard the swine producer against TGE.

Spacing Pine Christmas Trees

Scotch and white pines will do well when planted 5 feet apart, but red pines need at least a 6-foot spacing

W. F. BULKLEY

CHRISTMAS TREE growers need to plant as many trees as possible on an acre to use land most profitably.

Tree spacings in plantations have varied from 4 to 6 feet between trees in a row, with wider spacings between rows for wide-cutting mowers.

A 10-year project to find the minimum spacing between trees that would allow a grower to harvest good-quality, family-size trees was completed in 1967 at the University of Illinois Oquawka Field in Henderson County. A secondary purpose of the project was to develop an area for demonstrating techniques of greening up, shaping, and shearing at annual Extension field meetings for growers from Henderson, Mercer, and Warren counties.

Three commonly grown species — Scotch, white, and red pines — were used in the study. They were planted at spacings of 4 and 5 feet. Observations and experience indicated that these spacings were the smallest that would allow growers to harvest family-size trees 6 to 8 feet tall.

The study showed that Scotch and white pines will develop thrifty limbs with plenty of needles when they are planted at least 5 feet apart. Red pines need at least 6-foot spacings.

Scotch and white pines could be spaced 4 feet apart and red pines could be spaced 5 feet apart, but then growers would have to cut smaller trees in an earlier harvest. This would be generally unsatisfactory, since it would be difficult to shape the trees properly and get them ready for the early harvest.

More than 1300 trees planted

The Illinois Division of Forestry nurseries supplied planting stock that consisted of 2-year-old Scotch pine seedlings and 3-year-old white and red pine seedlings. We planted 447 trees of each species. Because of careful planting and good growing seasons, 97 percent of the trees survived.

The total area available for the planting was 0.6 acre, which was divided into six blocks, 50 by 90 feet. This permitted planting enough of the three species at both the 4-foot and the 5-foot spacing that we could observe closure of branches (contact between limbs of different trees) on a representative sample of trees. Tree locations were staked with a tape for accuracy and cross-checked to make certain trees were planted on squares.

Soils in the experimental area varied from Oquawka sand with some severe wind erosion to more fertile Hagener loamy sand and Disco sandy loam. Scotch pines were planted on the least fertile Oquawka sand, white pines on the fertile loams, and red pines on the blocks with intermediate fertility.

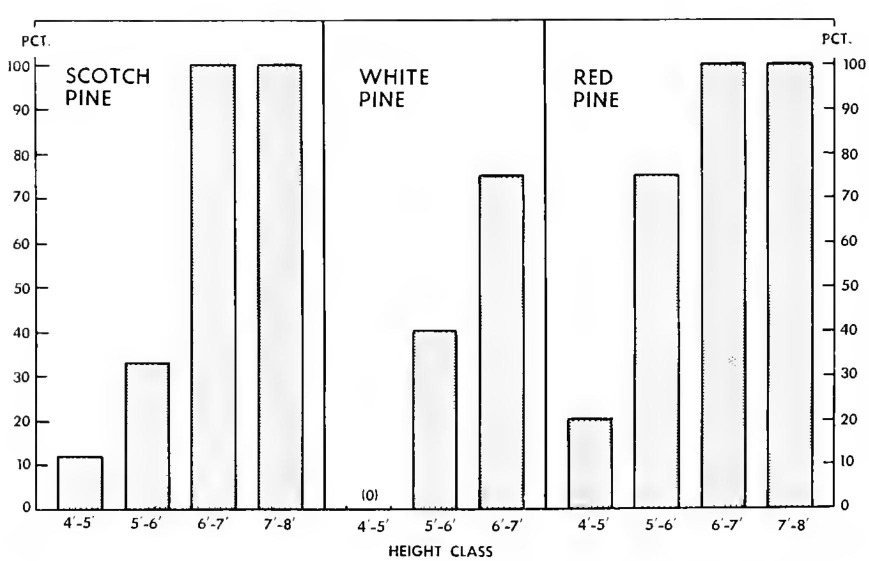
Care of stand

Only a few weeds grew on the Oquawka sand, but there were dense stands of weeds on the more fertile soils. Annual weeds and a patch of sweet clover in the white and red pine blocks were controlled during the first five years by mowing with a push-type rotary mower with a 36-inch blade. We applied a herbicide to the dense portion of the sweet clover patch the third year after planting to prevent weeds from injuring branches and killing several small white pines.

Shearing the trees to control their shape and increase the density of foliage was begun in June during the fourth growing season after planting. It was continued each June until the trees were harvested.

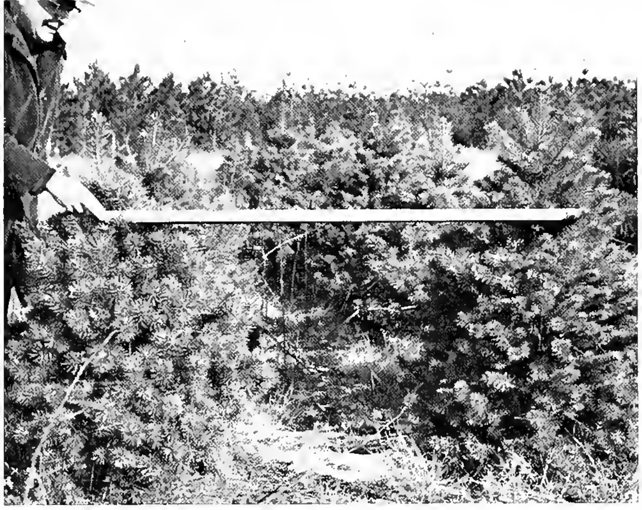
Trees measured before harvest

Before harvesting the trees, we measured the crown spreads of 20



Percentage of trees in each height class that had limbs which outgrew their radial space when trees were planted 4 feet apart. None of the white pines were more than 7 feet tall when measurements were taken. (Fig. 1)

W. F. Bulkley is Associate Extension Forester.



Spaced 5 feet apart, 6-foot-tall Scotch pines 2 years from harvest still have enough growing space that limbs can develop properly. (Fig. 2)

White pine can be sheared to a narrow base when spacing is 5 feet. Tree on left was crowded because it was left to grow more than 7 feet tall. (Fig. 3)

trees of each species in both the 4- and 5-foot spacing blocks. This was done by measuring the length of limb spread in two directions at the widest portion of the crown.

We also checked to see if any limbs had outgrown their allotted radial growing space (half of the space between trees). When this space had been outgrown, we determined whether the competition from adjacent trees had caused loss of needles or reduction in twig growth.

The trees that were measured were divided into four height classes — 4 to 5 feet, 5 to 6 feet, 6 to 7 feet, and 7 to 8 feet. No white pines at either spacing were allowed to grow more than 7 feet tall; nor were any of the Scotch pines with 5-foot spacings.

Harvest of Scotch pines was begun six years after planting; white and red pines, seven years after planting. It continued until all salable trees were cut. Trees were 5 to 8 feet tall when harvested, the majority being 5 to 7 feet tall. Whenever possible, salable trees were cut a year before probable contact with adjacent trees.

Effects of different spacings

The 4-foot spacing was too small to develop high-quality trees. Many limb contacts between adjacent trees were found among all three species at this spacing. This was particularly true of trees 5 to 7 feet tall. At such close spacing contact was unavoidable and would have increased if harvesting had been done a year later. If limb contact had been allowed to increase, the grade and value of many trees would have been reduced.

Another problem with the 4-foot spacing was that several trees reached salable size but were not yet at a salable grade. Holding them over for another year or two for additional shearing and shaping at close spacing caused a loss of needles and reduced twig growth on lower branches.

Both these problems were reduced somewhat by harvesting large trees growing next to smaller ones. But this did not justify 4-foot spacing of Christmas trees as a general rule.

The 5-foot spacing was acceptable for Scotch and white pines up to 7 feet tall. Red pines would not grow well with 5-foot spacing.

Scotch pines. All 6- to 8-foot tall Scotch pines that we measured in the 4-foot spacing block had some lower limbs that outgrew their radial growth space of 2 feet (Fig. 1). But Scotch pines with 5-foot spacing had plenty of space for limb growth. None of the Scotch pines with 5-foot spacing were more than 7 feet tall when harvest was begun.

White pines. About 75 percent of the 6- to 7-foot tall white pines with 4-foot spacing had some limbs that outgrew their radial space of 2 feet. There were no trees 7 to 8 feet tall at the time measurements were taken, but all such trees would undoubtedly have lost needles and been reduced in twig growth at the 4-foot spacing. White pine was the easiest of the three species to shape. The lower branches adapted to restricted shearing, but even so the larger trees did not do well with 4-foot spacing.

Some space problems were found in the 5-foot spacing blocks, although this spacing was generally adequate for white pines.

Red pines tend to develop a very wide crown, even with shaping. Because of this, the lower limbs of the smaller red pines outgrew their 2-foot radial growth space oftener than either Scotch or white pines of the same size. For this reason the 4-foot spacing was unacceptable. Even when grown with 5-foot spacings, 40 percent of the red pines 6 to 7 feet tall and all of those 7 to 8 feet tall outgrew their radial growth space of 2½ feet. Some of the lower branches were noticeably reduced in growth. Also, larger red pines shed more needles than is desirable.

Loss of needles due to close contact with adjacent trees when red pine were spaced 4 feet apart. (Fig. 4)

ROTOR AERATION OF SWINE WASTES

DONALD L. DAY, JAMES C. CONVERSE, and DON D. JONES

A METHOD OF treating city sewage is being adapted for the treatment of manure in swine confinement buildings. By this method, known as the oxidation ditch-type waste-treatment system, oxygen is added to the waste to reduce odors during the waste-treatment process.

The layout of a typical municipal oxidation ditch is shown in Figure 1. The principal parts of the system are (a) the continuous open-channel ditch that holds the waste, and (b) the aeration rotor for supplying the necessary oxygen and keeping the ditch contents in suspension. If the rotor is stopped for 30 to 60 minutes, the bacterial floc and solids will settle, leaving the purified water on top. The surplus water can be separated from the system in this way or by allowing the overflow to go into a settling tank.

After conducting laboratory tests on aeration of hog wastes, it appeared feasible to develop an oxidation ditch in a confinement swine house. With this method, self-cleaning slotted floors could be used without objectionable gases and odors coming from the gutter.

Details of a swine-finishing building incorporating the oxidation ditch are shown in Figure 2. With a floor area of 745 square feet, the building can accommodate 93 pigs with 8 square feet per pig. Twenty-nine percent of the floor is slotted. A continuous gutter beneath the slotted floor serves as the oxidation ditch, and a rotor keeps the solids in suspension and adds oxygen.

The first test

The first field test began on August 2, 1966. Eighty pigs averaging 120 pounds were used. The gutter was filled with tap water, and 100 gallons of activated sludge from the Urbana waste-treatment plant was added as an inoculum at the beginning of the test. Extreme foaming began during the fifth week of operation. The foam came up through the slotted floor and was a considerable nuisance.

Half of the ditch contents were pumped out, and the ditch was refilled with tap water. Excessive foaming began again during the seventh week, varying in intensity during the rest of the test. Some of the foam bubbles were analyzed for gas content by gas chromatography. Compared with normal atmosphere, the bubble gas was high in carbon dioxide and low in oxygen. The bubbles were very tough and hard to destroy. During the period of foaming, the gutter did not contain any measurable oxygen, and solids did not separate from the supernatant in the 30-minute settling test. At this time, the total solids in the mixed liquor were about 25,000 p.p.m. After 4 weeks of operation, the pH of the liquid had built up to between 8 and 8.5. It remained at this level during the rest of the test.

The hogs were removed on September 22, at an average weight of 200 pounds. Aeration was continued for 3 more weeks, after which the foaming subsided, dissolved oxygen was measurable in the ditch, and there was separation of sludge and supernatant in the 30-minute settling test. The ditch contents were then pumped onto a sand filter bed, but the water did not seep through very well.

The severe foaming during this experiment was attributed to an inadequate supply of oxygen — 0.45 pound per pig per day. Since the test was run, the following estimate has been made of the proper oxygen supply: The municipal biochemical oxygen demand (BOD) is 0.17 pound of oxygen per capita per day. A 100-pound pig has a population equivalent of 2, so that its 5-day BOD demand is 0.34 pound of oxygen per day. Since twice as much oxygen as the 5-day BOD demand is to be supplied, the daily oxygen requirement becomes 0.68 pound per 100-pound pig.

On the basis of an electricity rate of 2 cents per kilowatt hour, the power to furnish this much oxygen costs about half a cent per pig per day.

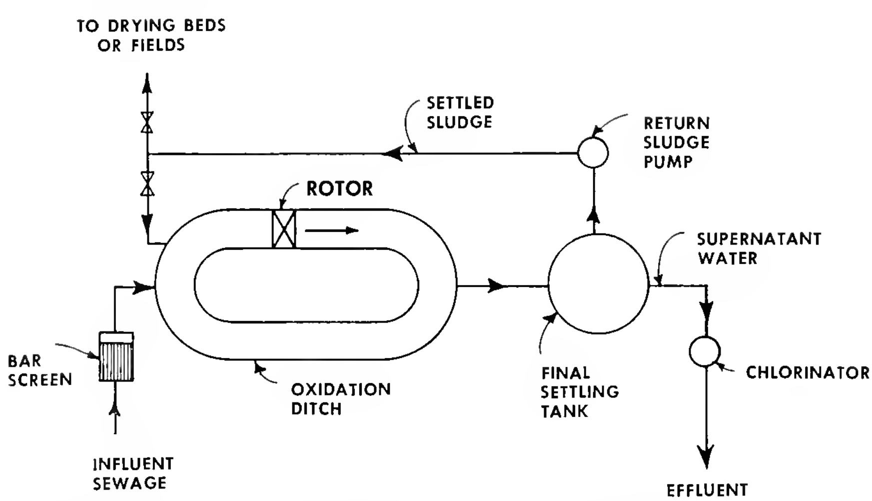
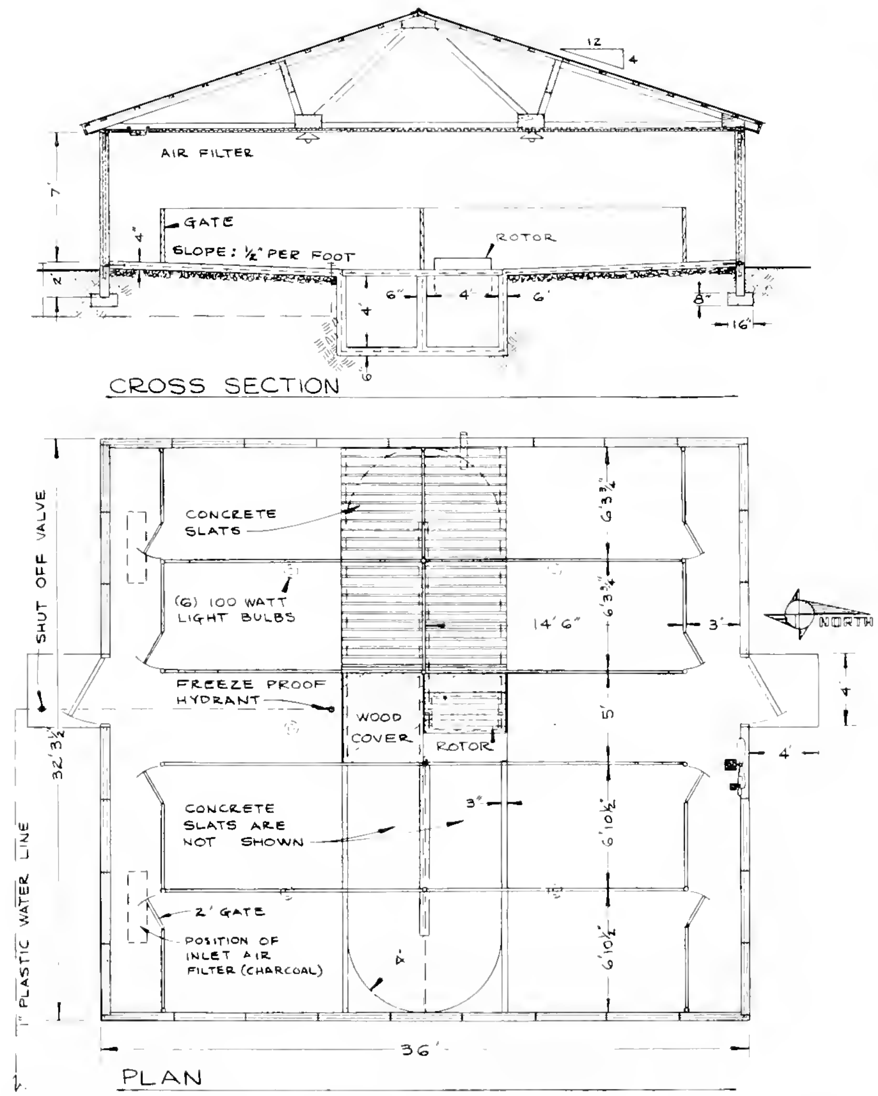
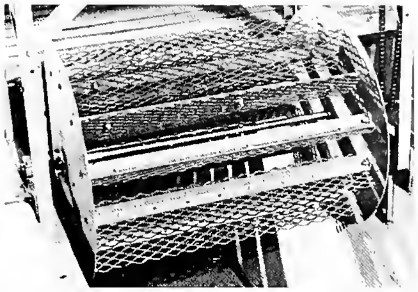


Diagram of an oxidation-ditch treatment plant for municipal waste. (Fig. 1)

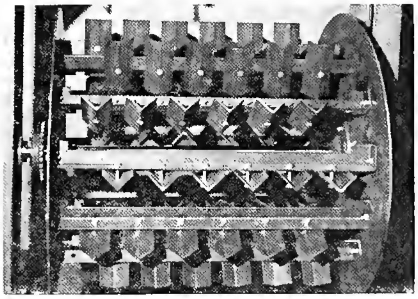
Donald L. Day is Associate Professor and James C. Converse and Don D. Jones are Research Assistants, Agricultural Engineering.



Field laboratory for aerobic treatment of swine waste using an oxidation ditch beneath partially slotted floor. (Fig. 2)



First aeration rotor used in the aerobic field laboratory. (Fig. 3)



A rotor with an angle-iron reel is now being tested. (Fig. 4)

The second test

The second test, which began on December 9, 1966, involved 40 pigs averaging 40 pounds. The rotor with the ¾-horsepower motor was used to supply 0.9 pound of oxygen per pig per day. An inoculum of activated sludge was not added at the beginning of this test.

Some excessive foaming occurred during the second week, but the foam was white and fluffy — not the tough type that occurred during the first test. Foaming was not a problem during the rest of the second test.

The foaming during the second test was probably caused by too great an initial volume of water for the amount of solids and bacterial floc present. This type of foaming is common in municipal aeration waste-treatment plants, when the plant is put into operation. The foaming usually subsides when the suspended solids reach about 2,000 p.p.m. and a satisfactory bacterial population is established.

Dissolved oxygen was maintained at a satisfactory level throughout the test. During the fifth week, an ammonia odor was very evident in the building, and appeared to be coming from the aerated waste. This odor subsided, however, during the ninth week, and did not recur. There was not a noticeable separation of sludge and supernatant after about the fourth week of operation. Microscopic examinations of the mixed liquor during the seventh week showed numerous ciliated protozoa typical of aerobic conditions.

Problems remain

Before the oxidation ditch can be unconditionally recommended for swine confinement buildings, several problems must be solved. The most immediate of these is the control of foaming. In addition, operational criteria (and perhaps additional stages of treatment) must be developed if the method is to serve for complete treatment of livestock manure, with an effluent that is acceptable by public health standards.

Control of odors from the gutter does not necessarily insure an odorless building, for odors can emanate from floor surfaces even when floors are completely slotted.

In view of the intensive research in progress both in the United States and abroad, solutions are surely forthcoming to problems of adapting the oxidation ditch for treating livestock manure.

"One Man, One Vote" and the County Board

JOHN HENDERSON

RECENT court rulings require that the "one man, one vote" principle be applied to county boards as well as to state legislatures.

In 1964 the U.S. Supreme Court ruled that the equal protection clause of the U.S. Constitution requires both houses of a state legislature to be apportioned on a population basis. Although this decision did not involve a local government, later decisions by a number of lower courts have held that local legislative bodies as well as state legislatures should be apportioned on a population basis. These decisions were upheld by the U.S. Supreme Court in March, 1968. The rulings of both the Supreme Court and the lower courts were based on the following lines of reasoning:

1. Local legislative bodies are subdivisions of the state, exercising legislative power delegated to them by the state.
2. The equal protection clause applies equally to the state and to its local subdivisions.
3. Since the state can legislate only through a legislature apportioned on a population basis, then if it delegates this power it must delegate it to a body that is similarly apportioned.

The philosophy behind these rulings is that every person, through his elected representatives, has a constitutional right to be heard and to participate in the government on an equal basis with all other individuals.

It would seem that if this right is to be protected on the state level, it should also be protected on the local level where governmental action can have a very direct and far-reaching effect on the lives of its citizens.

Attitudes about reapportionment

It is not clear just what effect the "one man, one vote" decision will have on the agricultural community. Some have forecast that this principle will actually destroy representative government and lead to dictatorship. Others view the court decisions on apportionment as a challenge to re-examine and improve this country's forms of local government.

Reapportionment has not had a startling impact on rural problems at the state level up to this time. An official of an agricultural association announced that the reapportioned 1965 Illinois legislature had taken favorable action on 85 percent of the legislative proposals favored by his organization.

Effects at local level

The effect of reapportionment at the local level is difficult to predict, but there is potential for great change. In a small, homogeneous rural county, reapportionment will have little effect. Its greatest impact will be felt in counties with substantial urban populations.

In Peoria County, for example, Jubilee Township, with a population of 476, has one representative on the county board; the Township of the City of Peoria, with a population of 103,462, has 15 representatives. In effect, each voter in Jubilee Township has 1/476 of one vote on the county board; each voter in the Township of the City of Peoria has 1/6897 of one vote.

In such counties, reapportionment may bring considerable development in county government. Some political scientists feel that, with reapportionment, county boards in counties with larger urban populations will assume a more positive governmental role than they have in the past. They also feel that county government will expand to include more area-wide functions and programs.

Local reapportionment, because of the nature of local governmental services and regulations, may have a more direct effect on the farmer than has state reapportionment. But it is doubtful that the effect of local reapportionment will be as immediate and far-reaching as some people have predicted.

The challenge of reapportionment

The agricultural community, rather than opposing reapportionment as the first step to a dictatorship, should consider its challenge. The transition may seem difficult at first, but if the problem is met with intelligence and a spirit of cooperation, reapportionment is probably less to be feared than the evil of a constantly increasing imbalance of representation on the local board.

Many of our forms of local government have long been condemned as archaic and unable to meet the demands of modern society. Reform is long overdue, but there is considerable sentiment for maintaining the present structure of local government. Can this structure be kept, while establishing a more equitable method of representation in the local government? The answer seems to be "yes."

The most obvious method of reapportionment would be to redraw district boundaries so they include about equal numbers of people in each district.

Another method would be to adjust the number of representatives from each district so each represents about the same number of people.

A third method would be to establish weighted voting. The supervisor from Jubilee Township might have 1 vote, for example, while each supervisor from the City of Peoria Township might have 13.

Still another alternative is to have elections at large from the entire county. This is now the practice in 17 Illinois counties that operate under the commissioner form of government. Each commissioner is elected for the entire county, allowing every voter the same representation.

John Henderson is Assistant Professor of Agricultural Law.

Lady Patricia, a new dessert grape variety

HIGH dessert quality, unusual "lady finger" berries, and exotic-appearing clusters characterize Lady Patricia, a new grape recently released by the University of Illinois. Lady Patricia has essentially the fruit quality of European or vinifera table grapes, but will grow in regions where these varieties are not successfully cultivated.

It was developed from a cross made in 1951 between Seibel 14664 and Seyve-Villard 20-365. The seedling was designated Illinois 182-1 in 1956.

At Urbana the fruit matures soon after mid-September. Clusters are large — occasionally very large, generally loose, long-tapering, and compound, with long peduncles. Berries, which are firmly attached to the pedicels, are large and golden yellow at full maturity. They have an attractive, very elongate, pointed, ovate shape termed "lady finger" by viticulturists. The flesh is tender, crisp, firm, and meaty, with a sweet, neutral flavor.

The skin is thin but tough, adheres to the flesh, and is slightly astringent until full maturity. Cracking has never been observed, and clusters keep well on the vine after maturity without decay or shelling.

The vine is vigorous and very productive, but overbearing should be prevented by cluster thinning and moderately severe pruning. Overbearing will lower fruit quality and vine vigor, and will also increase the severity of injury from low winter temperatures and volatile herbicides.

Bud burst after winter dormancy is late. This is one reason why Lady Patricia has escaped the severe injury that late spring frost and freezes have inflicted on many American-type varieties under comparable growing conditions. Lady Patricia has shown moderately severe winter injury in 2 years out of 12 since fruiting began, and it may be best adapted from central Illinois southward as well as in the grape-growing areas of the northeast.

This variety has considerable resistance to downy mildew. The disease has not been observed on clusters or foliage of vines grown under a minimal or no spray program at Urbana. Like all other bunch grape varieties grown in eastern North America, Lady Patricia requires a spray program for black rot control. Thus far the variety appears to be tolerant of other grape diseases. — *H. C. Barrett, Associate Professor of Plant Breeding in Horticulture*

Control of fruit set in tomatoes by use of Alar and gibberellin

ALTHOUGH mechanical harvesting of tomatoes is still in the experimental stage in Illinois, 153,000 acres were machine-harvested in California during 1967.

If tomato production is to continue or increase in Illinois, harvesting will have to be done by machine. This will necessitate changes in cultural practices and the development of varieties to provide for concentrated fruit set and a range of maturities over the harvesting season. Although cultural practices may be readily adjusted within the limitations of soils and climate, the development of varieties suitable for mechanical harvesting may take many years. Meanwhile we may have to alter the response of varieties to fill the gap.

Early varieties have a greater tendency to set fruit than late ones. Fruit production limits the size of plants, so early-fruiting types are usually small. If the early fruit clusters are removed, the plant continues to grow. If it is then allowed to set fruit later, a large crop is set within a short time. The concentrated set required for mechanical harvesting might therefore be provided by delaying the fruiting of early varieties.

Succinamic acid, a plant-dwarfing agent sold under the name of Alar, delayed fruit set in experiments last year. This chemical prevents synthesis of gibberellins and so restricts plant growth at first. Growth is not inhibited for long, however, and the treated plants soon become larger than the controls. Since Alar does not prevent the action of gibberellin, this chemical can be sprayed on inhibited plants to give an immediate fruiting response.

According to experimental results, plants should be sprayed with Alar at the rate of 2,500 p.p.m. about 2 weeks before flowering begins. If further delay of fruiting is desired, a second spray can be used about 2 weeks after the first. Gibberellins at the rate of 100 p.p.m. seem to be most effective 1 to 2 weeks after the Alar treatment. A variety capable of setting fruit at high temperatures is recommended when fruit set may be delayed until hot weather.

Alar has not been cleared for use on tomatoes, but no residue was found in fruits after early applications on the plants. Clearance can perhaps be expected by the time the effectiveness of Alar for spacing harvests and concentrating fruit set is finally determined. — *J. P. McCollum, Professor of Plant Physiology in Horticulture and Hazo Carter, former post-doctoral student*

FARM BUSINESS TRENDS

GOLD and national policies concerning it have been for centuries a big factor influencing farm prices and income. Hence farmers have reason to be concerned with the recent "gold crisis" and government policies to deal with it.

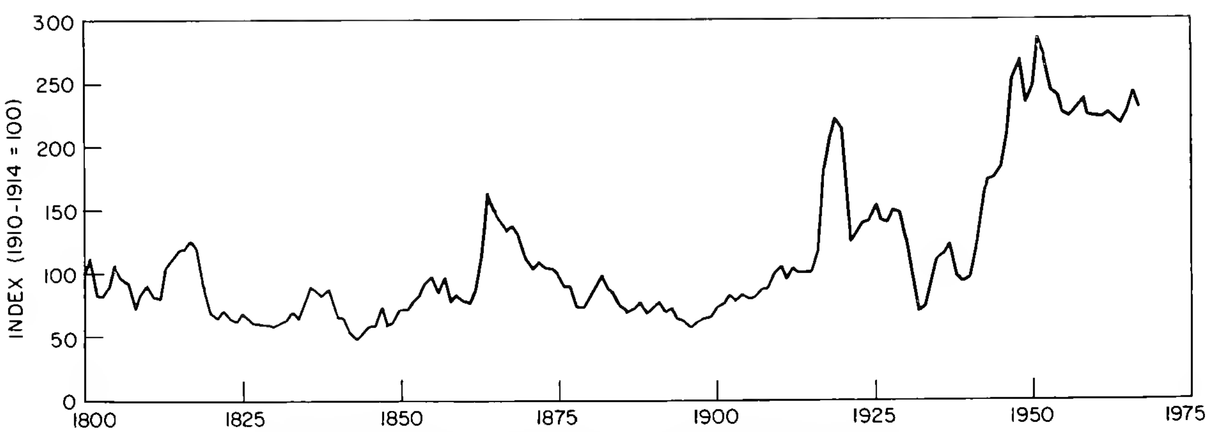
After Columbus discovered the Americas in 1492, the Spanish plunderers took large amounts of gold from Central and South America to Europe. The resulting increase in the supply of gold brought a long rise in the prices of farm products and other commodities.

Another rise in prices followed big discoveries of gold in California and Australia around 1850. A third period of price advances accurred from about 1895 to 1914, as a result of new production of gold in Alaska, the Yukon, and South Africa. This development raised prices of farm products to their highest levels, up to that time, in relation to costs of the things that farmers buy. The prices were so favorable to farmers that they have used the 1910-14 period for calculating "parity" prices for nearly 40 years.

Prices also rose during World War I and earlier wars, when the government temporarily restricted the free exchange of paper money for gold. As a result, the paper money gradually lost value; that is, prices went up. Prices came down when the government became able and willing to pay out gold again.

In 1933-34 our government stopped all payments of gold to individuals and made it illegal for anyone to own monetary gold. It also raised the price of gold from about \$20 an ounce to \$35. This in effect cut the dollar from $\frac{1}{20}$ of an ounce of gold to $\frac{1}{35}$ of an ounce. Both of these changes helped to promote the inflation that has occurred since 1933.

Recent and future changes in monetary policies concerning gold will have slow but inevitable and long-time influences upon the prices of farm products, farm income, and land values. — *L. H. Simerl, Professor of Agricultural Economics*



Wholesale prices of farm products in the United States, 1800-1967

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ILLINOIS RESEARCH

Illinois Agricultural Experiment Station

IN THIS ISSUE

Timely harvesting keeps soybean losses at a minimum

Two crops a year are grown successfully in southern Illinois

Statewide survey of nutrients in soils

Stages in a child's mental development

Parturient paresis in the dairy cow as related to rations

A mosquito is pinned for mounting in the specimen collection of the Center for Zoonoses Research. Mosquitoes were studied extensively in a recent encephalitis epidemic (page 10).

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ILLINOIS

Illinois Agricultural Experiment Station

CONTENTS

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Margery E. Suhre . . . . Editor, ILLINOIS RESEARCH

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NEWS AND VIEWS

Agriculture and the Environment

MODERN AGRICULTURAL PRACTICES have dramatically increased our ability to modify the natural biology of the plants and animals upon which basic food and fiber production depends. Improved understanding of the genetic characteristics of plants and animals continues to provide new ways of increasing their productivity. Recent research clearly indicates exciting possibilities for genetically modifying the chemical composition of grains. New knowledge concerning the basic physiology of cells suggests new ways for increasing the efficiency of production of both plants and animals. Methods for the control of weeds, insects, and diseases are becoming more specific and effective.

Although our capacity to modify and regulate the biological systems to improve their productivity has greatly increased, we must recognize that such practices may have side effects in other parts of the biological system that are potentially undesirable. With this thought in mind, agricultural scientists are expanding their studies in environmental biology, waste disposal, and pollution abatement. As our population increases, the use of our basic natural resources of land, water, and air will become more intensive and competitive. It is clear that agriculture, as well as other sectors of our dynamic society such as manufacturing, transportation, medicine, and housing, contributes to the total impact of the new products and practices that modify the complex environment in which we live. — *M. B. Russell*

Timeliness in Harvesting Soybeans

Losses can amount to a dollar an acre for each day that harvesting is delayed beyond the maturity date

D. R. HUNT and R. W. HARPER

TIMELINESS of harvesting soybeans will do a lot to reduce the losses caused by the imperfections of even the best combines and soybean varieties.

Combines do not cut low enough to get all the bean pods, to gather all the crop into the header, to thresh all the grain without damage, or to separate all the foreign matter from the yield.

Commercial soybean varieties do not stand erect enough, pod high enough, or resist shattering under stress. When the undesirable characteristics of soybeans are added to those of the combine, harvesting losses can be as high as 20 percent, possibly amounting to $20 per acre. The soybean grower should therefore seek all possible ways to reduce the effect of these imperfections.

Research workers check cutterbar losses of a combine in soybeans. Harvesting losses result from a combination of imperfections in both the combine and the soybean varieties. (Fig. 1)

Other causes of loss

Natural forces also affect the efficiency of soybean combining. Rainfall and cool temperatures delay harvesting by slowing the natural drying of the grain. Muddy fields and damp foliage interfere with operation of the combine. Hot and dry conditions cause rapid drying of the crop and may increase preharvest losses.

Market policies can influence the harvest of soybeans, as purchasers discount beans with high moisture contents. When beans are $2.40 per bushel, the effective discount rate is 2.8 cents per bushel for each percentage point of moisture above 13 percent. Because of weight reduction, beans drier than 13 percent are effectively discounted 2.7 cents per bushel for each percentage point of moisture loss. Purchasers also discount split beans at the rate of 0.05 cent for each percentage point above 20 percent of the total weight.

Testing bean harvest timeliness

The soybean producer must consider the interaction of all these factors if he wants the highest economic return. If he does this he will still be using an imperfect combine to harvest an imperfect soybean variety, but he will harvest at a time when his marketing penalty will be minimum and his net yield will give him as large a return as possible. This planning of harvesting to yield the highest economic returns is defined as timeliness.

During the fall of 1966 the Department of Agricultural Engineering ran tests to study the timeliness aspects of soybean harvesting.

The goal of the research was to total the effects of field losses and marketing discounts at several times during the season. This enabled us to develop curves that relate monetary loss to the time at which common soybean varieties are harvested by a commercially available, well-adjusted combine.

Common cultural practices were used in growing the crop. Two popular varieties, Harosoy and Shelby, were seeded in 30-inch row spacings at two different planting dates. Weeds were not a problem.

By harvest time 10 to 20 percent of the Shelbys were lodged, but the Harosoys were fully erect. Seven inches of rain interrupted the harvest for a total of 4 weeks, but the showers did little apparent damage to the crop.

Thirty-three harvesting tests were run. Grain moistures varied from 42 to 8 percent. The mean moisture content was 13.2 percent.

A conventional self-propelled combine was used to harvest plots measuring 5 rows wide and 300 feet long.

D. R. Hunt is Associate Professor of Agricultural Engineering, and R. W. Harper is a Graduate Assistant.

The combine was carefully adjusted to perform at its best for each day's conditions. A few morning tests were run, but most tests were conducted in the afternoon. Field speeds were varied from 1.8 to 5 m.p.h., but most tests were run at 3 m.p.h.

Sources of yield losses

The average loss for all tests was 7.88 percent of the total yield. This was very low, considering that some of the tests were delayed as much as 2 months. These low losses show the value of careful and continual combine adjustment.

The header loss was the largest loss, followed closely by the preharvest loss for the Harosoy variety. The rack-and-cylinder losses were much lower than the other two losses. The amount of foreign matter and damaged beans was very low. Very few split beans were found. No marketing penalty would have been assessed because of damage. Foreign matter averaged 0.69 percent of the total yield for all tests.

Losses from untimely harvesting

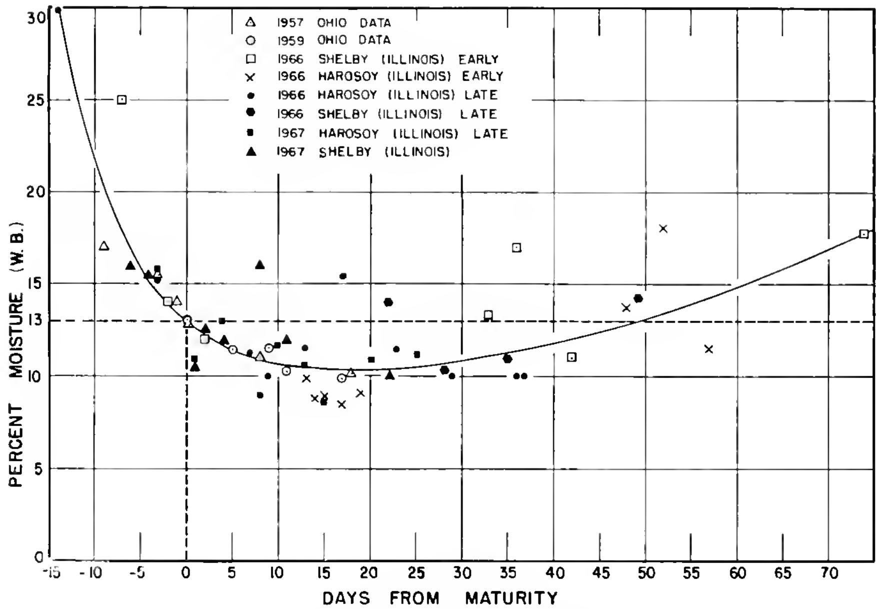
A computer program was used to obtain field-loss figures from untimely harvesting for both varieties. This loss of yield can be combined with market discounts for too much or too little moisture content if the field-drying characteristics of soybeans are known. Drying characteristics were calculated by combining the data from this and other studies, and the resulting curve is shown in Figure 2.

The effects of field loss, moisture content, and marketing penalties for each variety were totaled to get the timeliness curves in Figure 3. The slopes of the curves on each side of their lowest points show the losses caused by untimely harvesting.

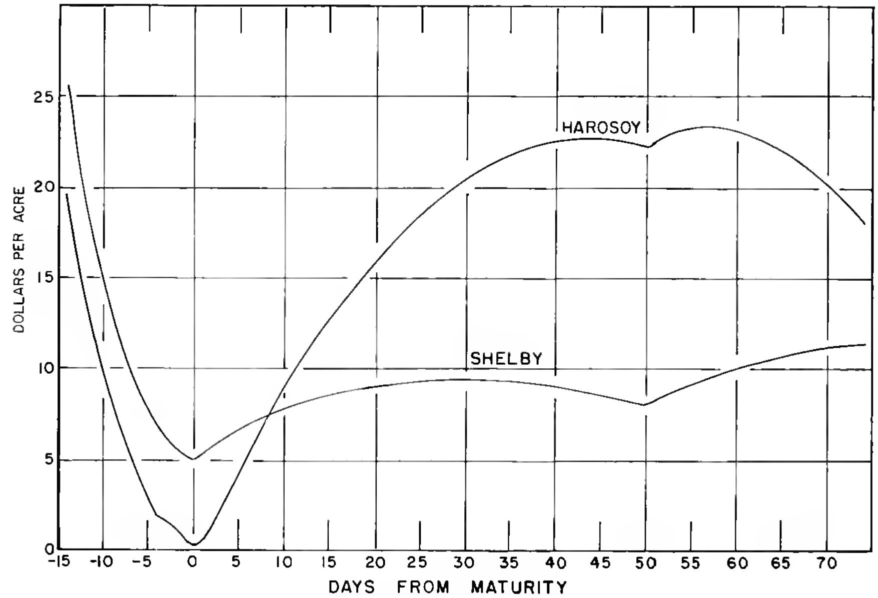
Obviously, the best time to harvest is at the maturity date, which we define as the time when the moisture content is 13 percent. Before that time dollar losses consist mostly of marketing penalties for high moisture. Losses after that time consist of both field losses and marketing losses for over-dry grain. The dollar amounts of those losses are staggering. Harvesting 10 days on either side of the maturity date amounts to \$10 reduction in income for each acre of Harosoys (Fig. 2).

A simple rule to remember is that it costs \$1 per acre for each day of delayed harvest for Harosoys. The penalty for the Shelby variety is not so bad, since each day of delayed harvesting costs about 30 cents per acre. Penalties for early harvesting are much greater.

Farmers need to give special attention to this timeliness effect when they select the size of their next combine. They may need a combine much larger than they thought they could afford.



Field-drying characteristics of Shelby and Harosoy soybeans. (Fig. 2)



These curves show how much it costs a farmer to harvest soybeans before or after they are mature (13 percent moisture content). (Fig. 3)

Corn Kernel Red Streak Disease

H. H. THORNBERRY

IN OCTOBER, 1966, a disorder now known as corn kernel red streak (CKRS), was noted on harvested ears of corn in Iroquois County. This was the first known occurrence of the disease in Illinois, although it probably occurred undetected before then. Severity of the disorder varied from barely perceptible streaks on only a few kernels of an ear — and these streaks not observable until after the kernels had been removed — to conspicuous discoloration of all kernels.

Judging from reports by growers and Extension advisers over the past two years, the disease appears to be widespread in the state, being most frequently observed in the northeastern areas.

Cause of CKRS

According to present experimental data, the disease is not caused by an infectious agent. Rather, the cause seems to be a toxin secreted by a species of eriophyid mites while feeding and colonizing on corn.

Microscopic examination of discolored ears revealed large numbers of these mites, which were identified by Dr. L. J. Stannard of the Illinois Natural History Survey as *Aceria tulipae*. Since this species is a known vector of wheat streak mosaic virus (WSMV), transmission tests were made to determine whether WSMV was involved. Live mites from affected corn kernels were transferred to the leaves of young corn and wheat seedlings growing in an insect-proof lighted chamber at 77° F. The leaves on which the mites colonized and fed developed mottling and some distortion. But inoculation of healthy corn and wheat leaves with expressed sap from the mottled leaves did not produce symptoms over a three-week observation period. This suggested that the mottling was associated with mite feeding rather than with an infectious agent.

The experiment was repeated three times, and the findings were confirmed each time. Thus, the mites feeding on the CKRS-discolored kernels did not contain wheat streak mosaic virus or any other sap-transmissible virus capable of inducing observable symptoms in corn.

It seems likely that both the experimentally induced leaf mottling and the kernel discoloration occurring under field conditions were caused by a toxic, noninfectious substance secreted by the mite. Direct proof awaits the production of red-streaked kernels under controlled conditions that will exclude other likely factors.

The claim that streaking is not due to WSMV has been further strengthened by another experiment conducted in a carefully screened greenhouse. Without mites, no red streaks appeared on fully matured kernels of corn ears that had been infected with a known culture of the WSMV virus.

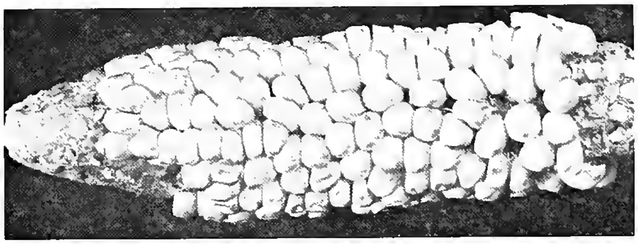
Effect on corn

The effect of the CKRS disease on the corn plant and kernels was also studied. Electron microscopic observations on ultrathin sections of corn and wheat leaves mottled from mite feeding revealed no virus-like particles in the protoplasm (nucleus or cytoplasm) of cells of affected tissue. Scanning electron microscopic observations on diseased and healthy kernel surfaces and the surface of leaves mottled by mite feeding indicated differences in surface contour and structure. The meaning of the differences is not yet known.

By light microscopy it was found that the discolored areas of kernels, appearing by visual inspection as solid red streaks, were made up of many very fine streaks of color.

Results confirmed in Ohio

Investigations at the Ohio Agricultural Research Center also indicate that the CKRS disease is not caused by either the wheat streak mosaic virus or the maize dwarf mosaic virus, but by mites, presumably by means of a secreted toxin. In addition, the Ohio investigators found that the disease did not diminish the nutritive value of corn grain.



Corn ear with discolored streaks. (Fig. 1)

At far left a magnified section of corn leaf shows *Aceria tulipae* mites and leaf stomatal cells. The mites are about 0.0002 by 0.0009 inch, or 3 times the size of the leaf stomata. (Fig. 2)

At near left, corn kernels with varied patterns of discoloration. (Fig. 3)

H. H. Thornberry is Professor of Plant Pathology. Electron microscopy on ultra-thin sections of tissues was done by Mary Ruth Thompson at the Central Electron Microscope Laboratory; that on surface view of grain and leaves was done by the Engis Equipment Company, Morton Grove, Illinois.

DOUBLE CROPPING IN ILLINOIS

G. E. McKIBBEN and J. W. PENDLETON

FOR MANY YEARS farmers in the southeastern United States have grown two crops a year. Generally a winter small grain (wheat or barley) followed by soybeans has been the most profitable combination.

Double cropping would be expected to have more promise in southern Illinois, where the average frost-free growing season is about 210 days, than in the northern counties, where the growing season is 160 days.

Historically many practical problems have been involved in establishing a midsummer crop, even in southern Illinois. The major problem has been that rainfall in late June and early July is often too low for good germination and vigorous early growth. Other problems have included the disposal of small grain straw, seedbed preparation, post-planting cultivation, and weed control. The economics of a double-cropping program is also of prime importance.

G. E. McKibben is Associate Professor of Agronomy, Dixon Springs Agricultural Center; and J. W. Pendleton is Professor of Agronomy, Urbana.

Some of these problems may be taken care of with the recent development of selective chemical herbicides and of larger, more specialized farm equipment that can increase the speed of tillage, planting, and harvest.

Tests at two locations

To determine whether double cropping is now feasible in Illinois, experiments were started at the Dixon Springs Agricultural Center and at Urbana in 1967. The frost-free growing season is about 205 days at Dixon Springs and 175 days at Urbana.

At Dixon Springs, both corn and soybeans were planted after the Monon variety of winter wheat. The wheat was combined June 19, yielding 45 bushels per acre. The combine cutting height was about 18 inches. The stubble on half of each area to be planted to corn or soybeans was mowed to a 4-inch height on June 22. The corn and soybeans were planted in 30-inch rows on June 23 with a special "no-till" planter, made at Dixon Springs, which disturbs the soil only in a narrow band in the row area. Figures 1 and 2 show this machine and the corn after it was established.

No plots were cultivated after planting. Various pre-emergence herbicides in liquid form were broadcast at planting at the rates indicated in Tables 1 and 2. The wheat had been previously interseeded with a fescue-alfalfa mixture. Ordinarily a farmer would not interseed the small grain in a double-cropping system, but both grass and broadleaf weeds would be present at wheat harvest in many years.

At Urbana, Harosoy soybeans were interplanted in wider-than-normal

Corn is planted in wheat stubble with a special "no-till" planter made at the Dixon Springs Agricultural Center. (Fig. 1)

A good corn crop was established in the wheat stubble at Dixon Springs. (Fig. 2)

wheat rows. Some plots were seeded in mid-May before wheat harvest (Fig. 3). Others were seeded July 9, after harvest. On these plots conventional tillage methods were followed (plow, disk twice, plant, and cultivate). Four replications were made of each part of the experiment. At wheat harvest, the interplanted soybeans showed extreme drouth symptoms, so half of each plot was irrigated lightly.

Variable results

At Dixon Springs, where summer rainfall was above normal, double cropping was a great success (Tables 1 and 2). Yields of 36 and 38 bushels of soybeans and 106 bushels of corn were obtained following a 45-bushel wheat yield. Close mowing of the wheat stubble did not appear necessary for corn, and actually reduced soybean yields.

In the soybean trial, 1 quart of Paraquat was more effective in killing vegetation and reducing weed competition than either Amiben or Treflan (Table 1).

Atrazine applied alone or in combination with Paraquat did an excellent job in the corn plots (Table 2). The cheaper chemical 2,4-D did not kill the vegetation present, and resulted in reduced corn stands, growth, and yield.

The discouraging results of the Urbana trials are shown in Table 3. Rainfall at Urbana was below normal in 1967, and the two-crop system was totally unsuccessful whether the soybeans were interplanted in wheat or planted after wheat harvest.

Use double cropping cautiously

The midsummer rainfall patterns may always dictate the success of double cropping systems, but we hope to learn in the future whether certain cultural, machinery, or chemical practices might reduce the weather hazards and better ensure success. Right now, our advice would be not to go all the way the first time you try double cropping, but to try it only on a limited scale.

We do believe that minimum seedbed operations should be used in such planting systems, because with the generally high temperatures in mid-summer, conventional tillage practices simply increase soil-moisture losses. Commercial no-till planters are now becoming available, as well as better herbicides. A combination of the new planters and herbicides will allow double cropping systems to be used on sloping fields without great damage from erosion.

High-yielding early varieties will be desirable for any double cropping system, and timeliness in all operations will be a necessity.

Soybeans seeded in wheat did not do well at Urbana. (Fig. 3)

Table 1. — Yield of Soybeans Planted Directly in Wheat Stubble at Dixon Springs, Average of 3 Replications, Clark Variety

Stubble management[a]	Herbicide, qt./A.[b]	Yield, bu./A.
Mowed	Paraquat, 1 qt.	38.6
Unmowed	Paraquat, 1 qt.	36.1
Mowed	Amiben, 2 qt.	16.1
Unmowed	Amiben, 2 qt.	25.5
Mowed	Treflan, 1 qt.	19.6
Unmowed	Treflan, 1 qt.	27.7

[a] Wheat combined June 19, cutting height 18 inches; stubble on some plots mowed to 4 inches June 22; soybeans planted on all plots June 23.
[b] Pre-emergence broadcast applied June 24. In addition, all plots received a directed spray of paraquat July 17.
Rainfall record: June, 3.33 inches; July, 5.68 inches; August, 2.46 inches; September, 3.68 inches.

Table 2. — Yield of Corn Planted Directly in Wheat Stubble at Dixon Springs, Average of 3 Replications, DeKalb XL 45 Variety

Stubble management[a]	Herbicide[b]	Yield, bu./A.	Plant population
Mowed	Atrazine	105.5	21,127
Unmowed	Atrazine	106.9	19,021
Mowed	Atrazine + Paraquat	99.2	18,731
Unmowed	Atrazine + Paraquat	106.8	18,005
Mowed	2,4-D	29.3	16,916
Unmowed	2,4-D	37.6	17,134

[a] See footnote a, Table 1.
[b] Pre-emergence broadcast applied June 24. Acre rates were 2½ pounds Atrazine, 1 quart Paraquat, ¼ pound 2,4-D ester.
Rainfall record. See Table 1.

Table 3. — Yield Summary of Soybeans Interplanted in Winter Wheat, Planted After Wheat, and Planted Normally, Urbana, 1967

Wheat spacing	Soybean spacing	Yield, bu. A. Not irrigated	Yield, bu. A. Irrigated[a]
	Interplanting[b]		
Uniform 16″ rows	Midway between 16″ rows	0	15.4
Two 8″ rows with 1-row skip	Midway of skip, 24″ spacing	0	12.5
Uniform 24″ rows	Midway between 24″ spacing	4.7	16.2
Two 8″ rows with 2-row skip	Midway of skip, 32″ spacing	2.8	14.2
	Conventional planting[b]		
	Normal planting, 30″ rows	38.1	
	After wheat, 30″ rows[c]	0	

[a] Irrigated 0.7 inch on July 3 and July 13 following wheat harvest.
[b] Interplanting done May 11; normal planting, May 18; planting after wheat, July 9.
[c] These soybeans germinated poorly and reached a total height of only 8 inches because of the dry conditions.
Rainfall record: June, 1.68 inches; July, 2.36 inches; August, 1.38 inches; September, 1.54 inches.

Aerobic Digestion of Cattle Waste

D. D. JONES, B. A. JONES, JR., and D. L. DAY

UNTIL recent years, disposal of livestock manure was no problem. A farmer could simply spread it on his fields every few months.

Now this practice is being abandoned with the development of cheap, efficient, commercial fertilizers and with the proximity of new neighbors who object to the manure odor. At the same time, intensified confinement livestock systems are complicating the problem of waste disposal. This situation has caught the engineer off guard. His previous lack of concern about livestock waste management has created a great need for research to solve the problem.

How study was conducted

From studies of swine waste, it appeared that aerobic treatment of beef and dairy cattle waste would be feasible if a high-concentrate ration with little or no roughage were fed. Aeration units were constructed in the laboratory to serve as digesters (Figs. 1 and 2). Small amounts of acclimated activated sludge from a municipal sewage plant were put into the units initially, and undiluted manure was added daily for 26 days. The digester contents were then aerated for several more days to determine the decomposition characteristics of the waste.

Three different loading rates were studied for both beef and dairy manure to determine optimum rates. Actual conditions in a manure pit under a slotted floor in a confinement livestock building were simulated as closely as possible.

Dairy cattle study

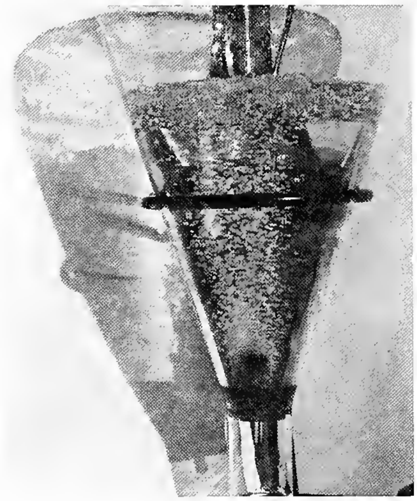
In the dairy cattle waste study, manure with a BOD (biochemical oxygen demand) concentration of 19,400 milligrams per liter and a VS (volatile solids) concentration of 50,000 milligrams per liter was added to digesters at loading rates of 125, 150, and 200 milliliters per day. During the 26-day period, total BOD reductions of 70, 60, and 76 percent and total VS reductions of 20, 15, and 0 percent, respectively, were obtained for the three rates. An average of 26 percent of the total nitrogen, 25 percent of the phosphorus, and 33 percent of the potassium were lost during this time.

All three digesters may have been slightly overloaded because of the extremely large amount of nonbiogradable organic matter present. Because of some settling near the end of the experiment, an optimum loading rate could not be determined.

Beef cattle study

During the beef cattle waste study, a manure with a BOD concentration of 8,000 milligrams per liter and a VS concentration of 30,000 milligrams per liter was added to digesters at loading rates of 100, 150, and 200 milliliters per day. Total BOD reductions of 59, 70, and 40 percent and total VS reductions of 38, 27, and 16 percent, respectively, were obtained for the three loading rates during the feed period. An average of 38 percent of the phosphorus and 21 percent of the potassium was lost.

Throughout the aeration period, a loading rate of 100 milliliters gave BOD and VS concentrations nearly as low as a loading rate of 150 milliliters. Since the maximum rate which yields good results will be the most efficient, a loading rate of 150 milliliters can be recommended for the beef waste. In terms of BOD and initial digester conditions, the F/M ratio, or the ratio of the pounds of BOD added per day to the pounds of VS in the digester, would be 0.114.



The method of oxidation used in the beef waste experiment. A similar method was used in the dairy study. Oxygen from the diffused air bubbles oxidized the biodegradable organic matter. (Fig. 1)

Three different loading rates were tried in each study. Beef waste is being aerated here. (Fig. 2)

A promising method

It can be concluded that, under conditions similar to those in this study, biodegradable organic concentrations can be significantly reduced without odor problems or appreciable losses in fertilizer value. Although the treated waste is still too polluted to be discharged into streams, the aerobic digestion process does show considerable promise as a primary treatment to be followed by a lagoon or other secondary treatment. Aerobic digestion should be used with caution, however, until such difficulties as foaming have been resolved.

D. D. Jones is an Assistant; B. A. Jones, Jr., Professor; and D. L. Day, Associate Professor, all in Agricultural Engineering. This project was sponsored in part by Public Health Service Grant No. UISW00018.

Weaning Beef Calves at 80 Days of Age

B. E. BREMER, F. C. HINDS, and P. E. LAMB

EARLY WEANING of calves can increase the amount and efficiency of beef production.

Calves that are not weaned until the usual age of 6 to 8 months often reach a growth plateau between 4 and 7 months of age. Also, weaning weights are likely to vary widely, partly because the cow's milk production generally starts to decline about 2 months after calving. A calf's true growth potential usually cannot be determined until after a postweaning feeding trial.

Early weaning would diminish the dams' influence and would permit earlier evaluation of growth potential. It would also overcome the inefficiency of converting feed into milk and milk into gain. Cows on good pasture convert only about 30 percent of the digestible organic matter of their feed into milk. Then it takes about 10 pounds of milk for a pound of calf gain.

After the calves are weaned, the cows could be put on a maintenance diet. The extra feed could be used to maintain other cows or fed directly to the calves. Thus more cows could be carried per acre of pasture and better use made of the lower quality forages that do not promote high milk production.

Early weaning might be an integral part of a drylot beef cow operation. In a fall calving program, early weaning would permit better use of low-quality wintering forages. It might be a necessity in times of drouth. And it would help solve the problems created by multiple births and by first-calf heifers.

The success of early weaning will depend partly on the diet the calves have been receiving. According to various studies, the rumen will be fully developed in 8-week-old calves that have been allowed roughages and grain, but not in calves that have received only milk. It still is not known, however, whether a calf of this age, even with a developed rumen, can digest enough dry matter to grow at its maximum potential.

In view of these facts, 80 days was the age at which 24 Angus-Hereford crossbred calves were weaned in a recent Illinois study of early weaning. The calves had access to creep feed for about a month before weaning, to accustom them to dry feed and to enhance rumen development. After weaning, they were divided into four equal groups, each group receiving a different level of protein for 70 days (Table 1). Calves were full-fed individually.

No significant differences were found between the four rations in average daily gain, feed consumption, feed efficiency, rumen pH, blood ammonia, or concentration of volatile fatty acids in the rumen (Table 2). As expected, the level of blood urea increased with increased protein concentration in the diet.

The 24 calves consumed an average of 3.4 percent of their live weight in air-dry feed and used 4.4 pounds of feed per pound of gain for the period. They adapted to early weaning with few difficulties. During the first 14 days after weaning, their daily feed intake averaged 5.7 pounds; daily gain, 1.9 pounds. There were very few cases of scours and none of bloat.

Initial values for rumen pH and concentration of volatile fatty acids indicate the calves were functioning ruminants at weaning. The gains indicate that all rations supplied enough energy and protein for good growth.

An early weaning program may increase the requirements for labor and equipment, and possibly for concentrates and protein supplements. Although early weaning appears to have many real advantages, it would not be advisable under all conditions.

Table 1. — Composition of Four Postweaning Diets

Ingredient	Diet[a] I	II	III	IV
Corn, shelled cracked, lb.	685	588	491	394
Soybean meal, 50 pct. C.P., lb.	40	137	234	331
Hay, ground, 15.75 pct. C.P., lb.	250	250	250	250
Bone meal, steamed, lb.	10	10	10	10
Limestone, ground, lb.	10	10	10	10
Salt, trace-mineralized, lb.	5	5	5	5
Crude protein, pct.	12.3	15.9	20.2	24.1

[a] All diets contained 1,000 international units of vitamin A, 200 I.U. of vitamin D, and 10 milligrams of aureomycin per pound of feed.

Table 2. — Summary of Results From the Four Diets

	Diet I	II	III	IV	Average
Weaning age, days	81.0	79.0	79.7	82.7	80.6
Weaning weight, lb.	191.5	200.2	196.3	212.8	200.2
Average daily gain, lb.	2.08	2.13	2.14	2.24	2.14
Feed per pound of gain, lb.	4.55	4.44	4.21	4.33	4.38
Change in plasma urea, mg. urea N/100 ml. plasma[a, b]	.28	10.20	14.15	20.44	11.27**
Change in plasma ammonia, mg. ammonia N/100 ml. plasma[a, c]	.28	.37	.23	.50	.34
Change in rumen pH[a, d]	.28	.13	.02	−.15	.07
Change in rumen volatile fatty acids, mM/100 ml. rumen fluid[a, e]	−2.94	−3.05	−6.09	−4.63	−4.18

[a] Figures are final values minus average initial values.
[b] Average initial plasma urea was 6.78 ± 1.65 mg. urea N/100 ml. plasma.
[c] Average initial plasma ammonia was 1.80 ± 0.78 mg. ammonia N/100 ml. plasma.
[d] Average initial rumen pH was 6.28 ± 0.52.
[e] Only three acids are included: acetate, propionate, and butyrate. Average initial concentration of volatile fatty acids was 11.57 mM/100 ml. rumen fluid.
** Significant at the 0.01-percent level.

B. E. Bremer is a graduate student; F. C. Hinds, Assistant Professor; and P. E. Lamb, Assistant, all in Animal Science.

Mobile reservoir. Birds are captured in mist nets. Because of their mobility, their role in disseminating virus is of great interest to ecologists at the Center.

Small mammal trap. Captured small mammals are tagged, bled, and released in a study area. When they are recaptured, changes in antibody patterns yield valuable information about the emergence and recession of virus.

Light traps. A 6-volt battery is used to light this portable trap and to blow the attracted mosquitoes and other insects into the collecting bag. Sometimes dry ice is used as bait.

THE SEARCH IN ZOONOSES RESEARCH

JACK HAYES and H. A. CATE

More than 100 diseases can be transmitted between animals and man. Such diseases, known as zoonoses, include rabies, yellow fever, sleeping sickness, and tuberculosis.

Quite obviously, zoonoses are of special concern to the physician and veterinarian. But the skills and knowledge of many other kinds of scientists are also needed to conduct meaningful research on these diseases. For one thing, disease agents vary widely from viruses to bacteria and molds and from protozoa to worms. Also, zoonoses are significantly affected by climate, migrating birds and animals, a constantly mobile human population, terrain, a variety of insect vectors, soils, and even plant-animal relationships.

The University of Illinois Center for Zoonoses Research, established in 1960, represents the first attempt by a major university to focus the resources of several colleges and departments on the problems of zoonoses.

The Center has established several areas in southern Illinois and neighboring states for observations on the emergence and recession of disease in nature. Focal point for the field work is the Dixon Springs Agricultural Center, near the confluence of the Ohio and Mississippi Rivers. These rivers are flyways for large numbers of migrant birds, and the area has many permanent bird residents, as well as many species of mammals.

Birds and mammals are trapped, tagged, bled, and released, and their blood is sampled for the presence of antibodies which indicate disease. Mosquitoes and the external parasites of animals are also collected and studied, since they transmit disease from animal to animal and from animal to man.

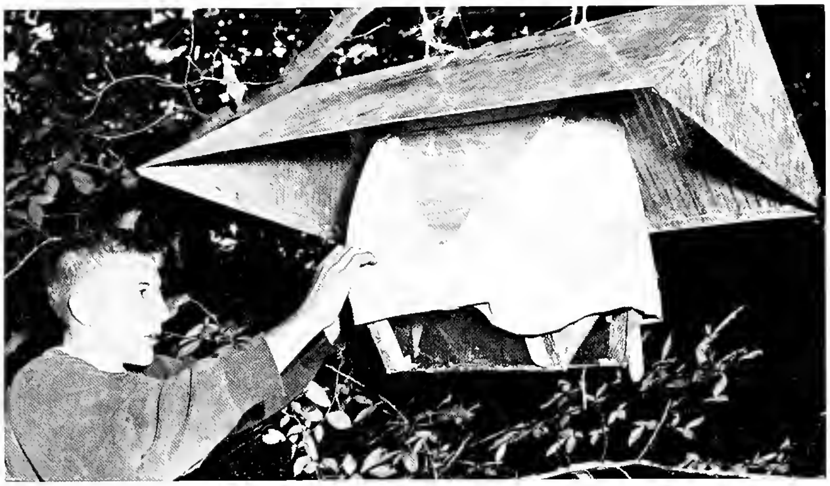
Laboratory tests to determine presence of virus in mosquitoes and animal tissues are conducted on the Urbana campus, as are antibody determinations from blood samples and wild animal susceptibility tests.

Arthropod-borne encephalitis has been the main zoonosis studied. When an epidemic of St. Louis encephalitis broke out in McLeansboro, Illinois, in 1964, the field team, with their multiple-discipline approach, were able to attack a variety of questions about the flow of virus from wild creatures to man in epidemic proportions. Physicians, veterinarians, entomologists, demographers, geographers, and botanists all converged upon McLeansboro from nearby field stations to pool their knowledge and talents.

In brief, the Center's research showed that the *Culex pipiens* complex of mosquitoes carried extremely large amounts of the virus; infection rates were high in house sparrows; other species of birds also carried the virus; and the inapparent infection rate in man was surprisingly low. (This research has been reported in detail in the *Journal of Medical Entomology*, Volume 4, Number 3.)

The Center is now continuing follow-up studies on encephalitis as well as studying other zoonoses.

Jack Hayes is Research Associate, Center for Zoonoses Research, and H. A. Cate is Extension Communication Specialist, Dixon Springs Agricultural Center.

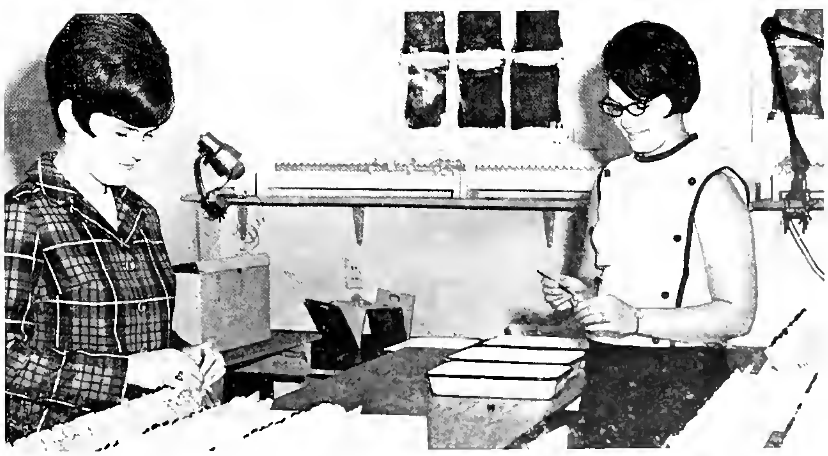


Trinidad trap. Baited with dry ice, birds, or small mammals, this trap attracts and captures blood-sucking mosquitoes. The dry ice consists of carbon dioxide, which is a byproduct of human respiration and attracts blood-feeding species.

Before and after. During the McLeansboro outbreak of St. Louis encephalitis, 615 individuals were bled in an attempt to learn how many had inapparent infection.

Rough sorting. Technicians sort different species of mosquitoes from other insects in the trap collections. Sorting is done on refrigerated tables to keep the virus viable after the mosquitoes die. An entomologist is responsible for the final positive identification of species.

Sorting into pools. Technicians put mosquitoes into groups of similar species. Entomologists verify the accuracy of the sorting.



Insectary. Adult mosquitoes are individually placed in test tubes and fed on raisins to determine if they can lay eggs without a blood meal. This characteristic is peculiar to one species and is a means of identification.

Nutrient Levels in Illinois Soils

W. M. WALKER, T. R. PECK,
S. R. ALDRICH, and W. R. OSCHWALD

Soil fertility levels and the nutritional status of corn and soybeans are generally adequate in 19 counties covered thus far in a projected statewide survey

PLANTS AND SOILS are both being analyzed in a current project to measure nutrient levels in soils throughout Illinois. The plan of the project, begun in 1967, is to collect plant samples from corn or soybeans growing on known soil types in every county of the state. Soil samples are also collected near the plants that are sampled.

The survey is being conducted by the Department of Agronomy and the county agricultural extension advisers with financial support from the fertilizer industry. One sampling site has been selected in every township. The sites are located on tracts which the U.S. Department of Agriculture and Soil Conservation Service designated as "conservation needs inventory areas" in 1956. The tracts represent a stratified random sample of the state.

As shown in the accompanying map, 19 counties were surveyed in 1967, and additional counties are being surveyed this year.

Sampling of plants and soils

Plant samples are collected at two growth stages — early and midseason. The early growth stage is defined as 12 to 18 inches in height for corn and 5 to 10 inches for soybeans. Whole plants are collected at this stage. The midseason stage is defined as the tasseling period for corn and full height for soybeans. At this stage the leaf opposite the ear is selected from corn plants and the topmost fully developed leaves are selected from soybean plants. Plant samples are analyzed for nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), manganese (Mn), iron (Fe), zinc (Zn), boron (B), copper (Cu), sodium (Na), aluminum (Al), and silicon (Si).

Soil samples are taken at three depths — 0 to 6 inches, 12 to 18 inches, and 24 to 30 inches. Soil tests are made for pH, available phosphorus (P_1), acid-soluble phosphorus (P_2), and available potassium.

Adequate levels

In the 1967 tests, which represent only the initial stage of the survey, average nutrient levels of both corn and soybeans were generally adequate (Table 1). High values for aluminum and silicon (Table 1) indicate some contamination by dust or soil. The decrease in aluminum observed in the second sampling probably indicates a decline in contamination. High levels of iron may also indicate contamination of the sample.

As shown in Table 2, mean pH of the surface soil was the same for both corn and soybeans. Surface-soil phosphorus and potassium were higher for corn than for soybeans. Subsoil phosphorus was also higher for corn, but subsoil potassium was not greatly different.

Shaded areas show counties in which plant and soil samples were taken in 1967.

Table 1. — Means of Various Chemical Elements in Corn and Soybeans

Element	Soybeans		Corn	
	First sample	Second sample	First sample	Second sample
N, pct.	4.28	4.66	3.50	3.11
P, pct.	0.35	0.29	0.35	0.26
K, pct.	1.97	1.54	3.59	1.02
Ca, pct.	1.41	1.17	0.42	0.60
Mg, pct.	0.60	0.45	0.29	0.34
Si, pct.	2.49	2.96	1.40	1.42
Mn, p.p.m.	69	74	54	56
Fe, p.p.m.	403	193	347	152
Zn, p.p.m.	50	50	38	34
B, p.p.m.	50	51	16	11
Cu, p.p.m.	18	15	14	12
Na, p.p.m.	283	288	215	172
Al, p.p.m.	290	213	100	42

Table 2. — Mean Soil Test Values for Corn and Soybeans

Depth, inches	Corn			Soybeans		
	pH	P_1	K	pH	P_1	K
		lb./A.			lb./A.	
0–6	6.3	82	371	6.3	42	332
12–18	5.9	29	262	6.0	11	283
24–30	5.9	27	279	6.2	10	292

W. M. Walker is Assistant Professor of Agronomy; T. R. Peck, Assistant Professor of Soil Chemistry Extension; S. R. Aldrich, Professor of Agronomy; and W. R. Oschwald, Associate Professor of Soil Classification.

A frequency distribution of surface soil test values is presented in Table 3. Extremely high test values for phosphorus and potassium were found in some of the samples — for example, 32 samples had P_1 tests above 200 pounds per acre and 24 samples had K tests above 800 pounds per acre.

Corn

Table 4 presents some correlations between results of the soil tests and the analyses of the plant samples. At both sampling periods soil test P_1 levels were positively correlated with the percent of phosphorus in the corn plant. A similar correlation was obtained for soil potassium and plant potassium.

An interesting aspect of this survey was the positive correlations between plant zinc and soil phosphorus. This contrasts with previous findings, which have associated zinc deficiency with high soil phosphorus. It is possible that the sampled sites have a history of fertilization with barnyard manure or that some of them may have been fertilized with micronutrient mixtures, thus explaining the different relationship observed in this study.

A possible association between boron in the plant and soil potassium was investigated. A positive correlation was found, especially at the second sampling. The higher correlation at the second sampling may be due to the plant part sampled or to stage of growth.

Percent calcium in the corn leaf was not closely associated with soil pH in this study. Soil acidity is usually corrected through use of agricultural limestone, which contains large amounts of calcium carbonate. It might therefore be expected that increased levels of calcium in a limed soil would be reflected in the plant. However, variable levels of soil calcium did not greatly influence leaf calcium. None of the plant samples were deficient in this element.

A problem associated with both corn and soybeans on low pH soils is the toxicity of excess manganese. This toxicity has been observed on corn and soybeans in southern Illinois. The negative correlations shown in Table 4 indicate that manganese levels in the corn leaf decreased as soil pH increased. Manganese is more soluble under highly acid conditions, so decreasing the acidity of the soil decreases the solubility of soil manganese.

Soybeans

As shown in Table 4, soil test levels of both phosphorus and potassium were correlated with the percentages of these elements in the soybean plant. Soil potassium was correlated with the boron content of the plant at a 10-percent probability level. As with corn, a highly significant negative correlation was found between plant manganese and soil pH. Other correlations were not particularly close and will be evaluated further as more samples are obtained.

Continuing studies

On the basis of samples obtained in 1967, we can say that the fertility status of Illinois soils and the nutritional status of corn and soybeans are reasonably adequate.

Some very high and some very low values suggest specific problems on individual fields. For example, some soil potassium values of more than 2,000 pounds per acre (300 pounds is considered high) were obtained. This recalls the suggestion in many textbooks that there may be a negative correlation between percent potassium and percent magnesium in plants. Future research will have to determine whether there is a magnesium problem on the soils with extremely high potassium.

Since this report is based only on samples obtained in 1967, it is not intended as conclusive. As more data are obtained, the reliability of mean values will be improved and sounder conclusions can be made about soil fertility and the nutritional status of corn and soybeans.

Table 3. — Frequency Distribution of Surface (0''-6'') Soil Test Values

pH range	Number of samples	P_1 test range (lb./A.)	Number of samples	K test range (lb./A.)	Number of samples
≤4.5	1	<10	17	<120	10
4.6-5.0	5	11-20	67	121-180	48
5.1-5.5	42	21-30	76	181-240	75
5.6-6.0	75	31-40	37	241-300	94
6.1-6.5	128	41-50	48	301-500	105
6.6-7.0	88	51-100	79	501-800	31
7.1-7.5	41	101-200	31	801-1100	10
>7.5	7	>200	32	>1100	14

Table 4. — Selected Simple Correlations Between Surface-Soil and Plant Nutrients and Between Nutrients Within the Plant, Corn and Soybeans, First and Second Sampling Stages

Factor correlated	Corn correlations		Soybean correlations	
	First stage	Second stage	First stage	Second stage
Pct. P with P_1	.134†	.245**	.141	.221*
Pct. K with soil K	.399**	.304**	.308*	.274**
p.p.m. Zn with P_1	.258**	.176**	−.210	−.001
p.p.m. B with soil K	.053	.152*	−.052	.181†
Pct. Ca with soil pH	.	.074	. . .	−.107
p.p.m. Mn with soil pH	. . .	−.198**	. . .	−.396**
Pct. K with Pct. Mg	−.397**	−.373**	−.230†	−.146
Pct. P with p.p.m. Zn	.297**	.214**	.269*	.027

† Odds are more than 9 to 1 against a chance correlation this large.
* Odds are more than 19 to 1 against a chance correlation this large.
** Odds are more than 99 to 1 against a change correlation this large.

The Human Organism as Information Processor

LELAND VAN DEN DAELE

Recent trends in psychology have given a new view of the child's cognitive-valuative development

THE STUDY of child development has changed a great deal during the past 10 years, reflecting new trends in American psychology.

Until the last decade, the dominant motif of that psychology was a concern with the observable aspects of human behavior. Such "unobservables" as thinking, feeling, and valuing were suspect constructs, useful only to the degree that they could be translated into some "seeable" response. In fact, thinking was equated with subvocalized speech and feeling with palmar sweat. In this way, thinking and feeling were, for a time, rescued as subjects of study. The pure behaviorists, however, would have little to do even with such sanitized measures. For "if you can't see it, it isn't." The general orientation of psychology was naively empiricist.

Sputnik introduces new era

Perhaps it is an oversimplification to date the sunset of rampant empiricism to the launching of Sputnik. But Sputnik symbolizes a new era of scientific conquest and technology. Sputnik represents an age of the servomechanism and the computer, of self-correction and information processing. The focus shifts from the *without* to the *within*. Marshall McLuhan attributes this change of world view to the impact of the communications media, but it is sufficient to characterize the change as a consequence of a new technology and a new vocabulary.

The new era provided new metaphors for an old psychology. Thinking, feeling, and valuing as areas of study were re-legitimized; and even consciousness, a somewhat embarrassing but ever persistent human characteristic, was reintroduced as a proper scientific concern. Psychologists constructed computer programs to simulate problem-solving, theorized about feedback loops within the brain, and examined stimulus patterns for redundancies and noise. Psychology found new clothes.

But new clothes do not fit without some stretching and alteration. In fact, there is even a period of learning to wear them. New metaphors do not provide magic solutions to problems, but merely provide new constructs and schemes of data arrangement. The solution to problems remains primarily inferential, and inferential analysis is painstaking and demanding work.

Human development central problem

One of the central concerns of the new psychology is the problem of human development. Investigators, by and large, agree that the adult is not merely an enlarged infant (he may be that, but he is probably more too). In line with the new technology, the new psychology asks what the information-processing characteristics (the program) of the child and adult are. The question is significant for it presumes the child and adult are active agents, not simply the reactive products of various stimuli like the well-known carrot and stick.

Information processing encompasses ways of organizing and rationalizing data, choices, and values; that is, it includes both a cognitive (logical) component and an affective (emotional) component. The logical component alone is not enough to explicate the observed behavioral differences between the child and the adult, or even between one adult and another. The same logical operations may be implemented to justify beer drinking or teetotaling.

Although no necessary relationship exists between logic and emotion, certain concordances arise between modes of rationalizing and values. These concordances probably derive from two factors: first, certain ways of thinking facilitate the evaluation of external attributes as psychologically important; and second, certain ways of thinking are associated with particular interpersonal settings: the family, the peer group, and the society.

Prerepresentational stage

The early orientation of the child is prerepresentational.[1] During the first 18 months or so, the child constructs the framework for later cognitive-behavioral acquisitions. From his perceptions and experiences, the child forges a world in which objects and, in a sense, the self possess a relative permanence and predictability. The earliest "value" orientation is represented as a turning toward the flamboyant and spectacular, toward objects or persons associated with speed, bright color, physical prowess, or agility. This type of value orientation is important to the business of exploration and discovery.

Preoperational stage

When the child is about 1½ years old, he enters the second major stage of information processing, or the preoperational period. During this stage, which lasts until about the age of 7, the child gradually develops the facility for representational thinking.

[1] The discussion concerned with cognitive capacities is derived primarily from Piaget (Flavell, 1964); and the discussion of values from Van den Daele (1968), Kohlberg (1963), and Erikson (1963).

Leland Van den Daele is Assistant Professor of Child Development in the Division of Child Development.

In one of the tests given in the Child Development Laboratory, a child is asked to pour artificially colored water from a jar into several cups, and then to tell whether the amount of water in the cups is the same as the amount in the jar before the liquid was poured. Whatever his answer, he is asked to justify it. The four-year-old in this picture answered "the same," and properly justified his response — an achievement indicative of very high intelligence. Most preoperational children answer "more liquid" (because there are more cups) or "less liquid" (because the liquid level is lower).

A major acquisition is the achievement of dichotomous classifications such as big and little, nice and not-nice, and good and bad. Associated with this achievement is the radical shift in motivation from excitation to the emulation of parental behavior patterns and values. During this period "Daddy" and "Mommy" are invariably "good."

Concrete operational stage

The third major stage, spanning the ages from 7 to about 11, ushers in concrete operational thinking. The child learns to perform reversible mental operations and to understand certain types of transformation. For example, the child recognizes that the amount of water is the same when poured from a tall container to a shorter one, a judgment not usually rendered by the preoperational child.

An early achievement of the concrete operational period is the child's recognition of before-after and elementary cause-effect relationships. This recognition results in a kind of naive pragmatism: The child rejects certain behavior patterns but chooses others that are consistent with values he internalized in the preceding stage. The parent is still the primary model, at least at the beginning of the period, but now the child evaluates and selects parental behavior patterns.

Gradually parents are displaced by the peer and social group. The child learns quickly that the obvious differences between boys and girls are important: Boys are expected to act like boys; and girls, like girls. This discovery eventuates in an orientation to the sex role, replaced later by a social-conformity ethic, a rather literal-minded, cliche-ridden acquiescence to peer group norms. These norms are more general than those applying to the sex role *per se*. These are the rules of good relations and "nice guymanship" which apply to both males and females and regulate social interaction in a variety of extra-sex roles.

Formal operational stage

The final stage of cognitive development is the period of formal operational thinking extending from 11 years of age to adulthood, although most individuals do not develop the ability for combinatorial thinking until about 14 or 15 years of age.

With the achievement of this stage, the child may deduce by means of hypotheses and not merely from concrete facts. Thus he may systematically eliminate alternative solutions to a problem such as finding the proper mixture of colors to produce a third color. Reasoning is *a priori* (before the fact) rather than *a posteriori* (after the fact). With this mode of thinking, the child becomes oriented to the implicit principles from which social rules are derived, and may modify rules to fit situations. Social rules are no longer construed as black and white, but the feelings and needs of others are considered.

From this point to later maturity, individual values become more differentiated, as if the reflective process acted as its own catalyst to provide new solutions to the complex problems of interpersonal and individual experience.

Organism is active

This brief sketch of cognitive-valuative stages provides a general outline of the kind of information-processing changes that characterize the developing person. This sketch implies a view of the organism as an open system in equilibrium with the physical-social environment. The organism is active, not passive, determining as well as determined. This conceptualization, along with the new technology, is generating a new vision of human development. The era of the empty organism is past history.

Postpartum Variations in the Blood Composition of the Dairy Cow as Associated With Prepartum Rations

K. A. KENDALL, K. E. HARSHBARGER, R. L. HAYS, and E. E. ORMISTON

Of the many cows used to study parturient paresis (milk fever) at the University of Illinois, a Jersey known as cow 1743 has acquired a unique distinction. For six successive parturient periods, her blood serum was analyzed during the several days before the expected calving date and at frequent intervals following parturition. The object was to learn more about the effects of various feeding regimens on serum composition and on the development of parturient paresis.

Much research has been done

The blood serum of the dairy cow as it relates to the paretic syndrome has been of major interest for several decades. A cow's actual metabolic status is reflected more accurately by blood analyses than by the presence or absence of paretic symptoms during the first 24 to 36 hours after parturition.

Usually parturient paresis is associated with a decline in serum calcium and an even greater decline in inorganic phosphorus. However, many cows may approach borderline levels of these serum minerals without exhibiting the symptoms that characterize the typical paretic case.

Research studies continue to reveal the effects of different feed regimens on the composition of the parturient cow's blood serum. Some feeding practices have been accompanied by a nearly normal metabolic status around calving time as reflected in the blood composition. Others have been associated with declines in calcium and phosphorus levels great enough to be accompanied by a marked increase in the number of clinical paretic cases requiring therapy. The exact relationship between dietary components and the cow's physiology, however, is not yet fully understood.

Tests with cow 1743

In studies of cow 1743, the levels of serum calcium and inorganic phosphorus were studied in relation to both the levels of nutrients in different rations and to variations in supplemental calcium and phosphorus levels as shown in the table below.

Beginning late in the third gestation period, 1743 was fed the milking herd grain mixture at the daily rate of 0.5 percent of her body weight. Alfalfa hay was fed free choice during this period as well as during gestation periods 4 through 7.

After her third calving, she developed clinical parturient paresis and responded to calcium therapy. After this attack, she was considered a possible suspect for further paretic attacks at her subsequent parturition periods.

During the fourth and fifth gestation periods this cow was fed mixtures containing 94 percent ground corn or corn product (grits), 5 percent molasses, and 1 percent trace mineralized salt. These concentrate rations were used to reduce the total calcium and, to some degree, the phosphorus intake levels. Nevertheless, as indicated in the table and in Figures 1 and 2, the lowest observed postpartum serum calcium and inorganic phosphorus levels after parturitions 4 and 5 were substantially

Ration Mineral Levels Fed Daily and the Postpartum Blood Serum Composition at the Time of the Lowest Observed Calcium Level, Cow 1743

Parturition No.	Ration[a]			Blood serum, mg./100 ml.			Hours after calving	Milk fever
	Ca, gm.	P, gm.	Ca:P ratio	Ca	P	TRS[b]		
2	....	....	.....	8.0	2.52	36.1	21	−
3	88.3	25.7	3.43:1	4.2	0.78	60.4	12	+
4	69.8	20.4	3.42:1	7.0	2.03	55.1	4	−
5	68.9	17.7	3.89:1	7.0	1.44	61.6	26	−
6	96.1	79.5	1.21:1	4.5	1.18	87.3	19	+
7	175.3	38.7	4.52:1	6.0	.40	166.5	1.5	+

[a] Grain plus roughage was fed before parturition No. 2. Before parturitions No. 3 through 7, alfalfa hay was fed plus the following: No. 3, herd mix #50 (0.5% of body weight daily); No. 4, 94% ground corn, 5% molasses, and 1% trace mineralized salt (1% of body weight daily); No. 5, 94% corn grits, 5% molasses, and 1% trace mineralized salt (1% of body weight daily); No. 6, shelled corn (1% of body weight daily) plus 0.5 lb. NaH_2PO_4; No. 7, herd mix #50 (1% of body weight daily) plus 0.5 lb. $CaCO_3$.

[b] Total reducing substance.

The authors are all members of the Department of Dairy Science; K. A. Kendall is Professor of Nutrition; K. E. Harshbarger, Professor of Nutrition and Associate Head of the Department; R. L. Hays, Professor of Physiology; and E. E. Ormiston, Professor of Dairy Husbandry. Diagnoses of parturient paresis were made by members of the Veterinary Clinic.

higher than those after the third parturition. The paretic syndrome did not develop after either the fourth or the fifth calving.

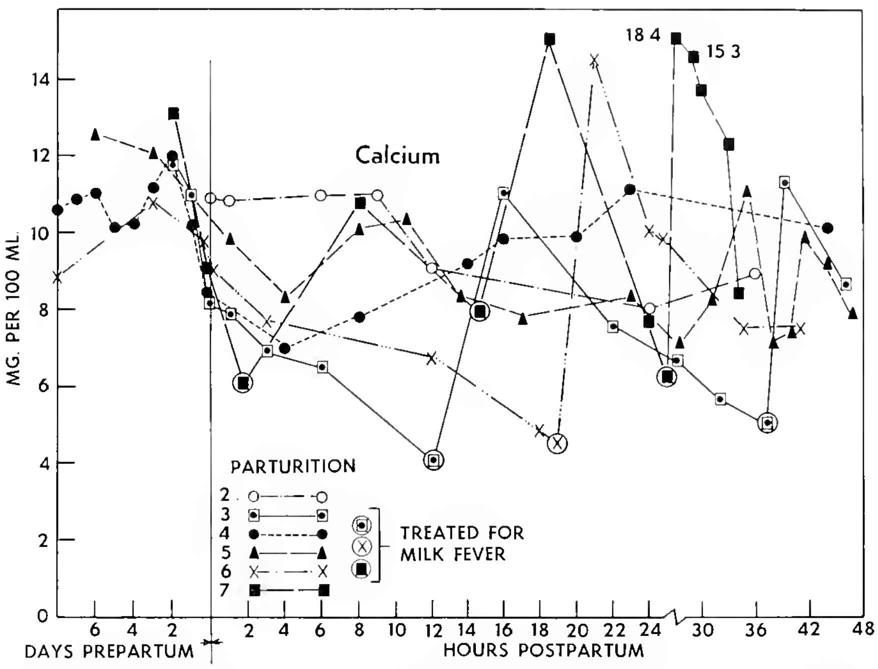
During the last 3 weeks of the sixth gestation period, a shelled corn-molasses ration, similar to that fed during period 3, was fed with 0.5 pound of monosodium phosphate added daily.

This level of monosodium phosphate has been recommended as a preventive measure against parturient paresis. It was ineffective at this parturition, however, for the cow did develop parturient paresis after her sixth calving. The attack was associated with a decline in blood calcium and inorganic phosphorus to levels of 4.5 and 1.18 milligrams per 100 milliliters, respectively. She recovered rapidly after receiving calcium borogluconate.

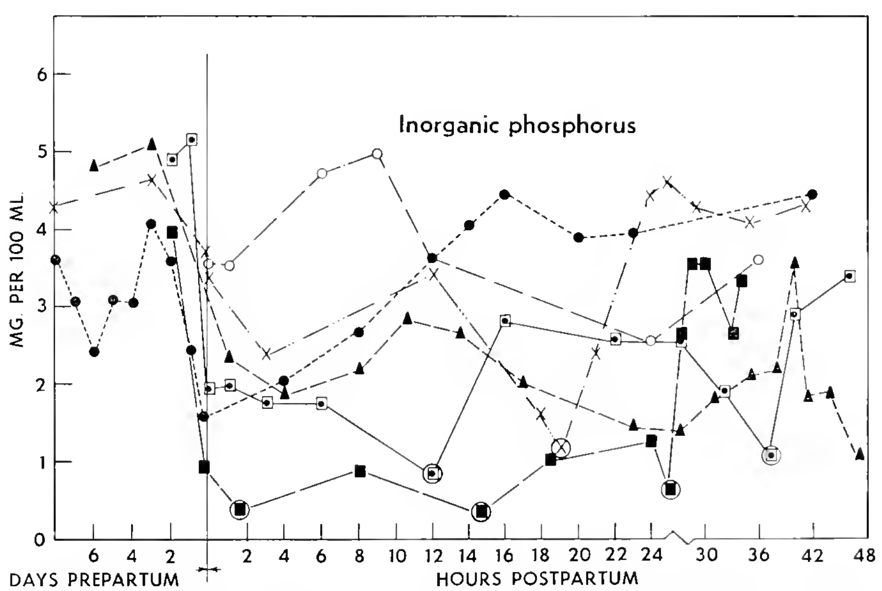
About 3 weeks before the seventh parturition, the diet was changed to the milking herd mixture fed during the third gestation, plus 0.5 pound of calcium carbonate daily. An hour and a half after parturition, the cow developed severe paretic symptoms, requiring therapy with calcium gluconate. The blood serum calcium and inorganic phosphorus levels at the time were 6.0 and 0.4 milligrams per 100 milliliters respectively (see table). Also at this time the total reducing substance (sugar) level in the blood serum was 166.5 milligrams per 100 milliliters — much higher than the levels observed at previous parturitions. At 14 hours and 26 hours after calving, recurring symptoms indicated relapses that required calcium treatment each time.

It is of interest that the level of serum phosphorus in relation to serum calcium was higher at parturition 6 following monosodium phosphate feeding than at parturition 7 after calcium carbonate feeding. Not only was the level of serum calcium higher after calcium carbonate feeding, but the serum inorganic phosphorus declined to 0.40 milligram per 100 milliliters, the lowest level ever observed in this cow.

Responses of cow 1743 to the several feeding regimens reflect the effects of diet upon the body physiology of the cow at calving time and during the critical 24 to 36 hours after parturition. The pattern of the parturient paresis symptoms in this cow suggests that the onset of the syndrome may be due to some factor or factors other than the ratio of dietary calcium to phosphorus fed during the dry period. The explanation for this possible underlying effect awaits further studies, some of which are now in progress.



Calcium levels in blood serum of cow 1743 after calvings 2 through 7. Rations fed before each parturition are given in the footnote to the table. (Fig. 1)



Inorganic phosphorus levels in blood serum of cow 1743 after calvings 2 through 7. See Figure 1 for a key to the different graph lines. (Fig. 2)

How a Sow's Pregnancy Is Affected by Distribution of Embryos in the Uterus

P. J. DZIUK

Distribution and number of embryos in a sow's uterus have a marked influence on whether she continues a pregnancy to full term.

The extent and nature of this influence have been studied in a number of research projects in the Department of Animal Science. Normal pregnancies were compared with pregnancies in which the number and position of embryos were experimentally altered.

Normal position of embryos

A sow's uterus can be divided into two horns, right and left, meeting at a "V" at the cervix and vagina (Fig. 1). Each horn is 3 to 5 feet long to accommodate the four to six fetuses that occupy it, much like peas in a pod.

The embryos enter the uterus from the oviducts about the third day after mating and remain near the tip of each horn until about the sixth day (Fig. 2A), when the embryos begin to move slowly away from the tip of the horn. By day 8 the embryos have reached the juncture of the two horns (Fig. 2B and E). At this time each embryo is about ⅛ inch in diameter.

The embryos continue to migrate into the other horn, so that by day 12 the embryos originating from each side have moved into both horns (Fig. 2D and F), and are mixed with embryos originating from the other side. About this same time the embryos elongate into delicate thread-like structures a foot or more long. The embryos also now space themselves quite evenly throughout the uterus (Fig. 1).

Soon after a gilt has been mated, she must decide whether she is pregnant, so her hormone balances can be adjusted to either maintain the pregnancy if one exists, or to prepare for the next mating if the first one was infertile. She makes this decision partly on the number and position of embryos in the uterus.

P. J. Dziuk is Professor of Animal Science.

Results of various alterations

If the uterus is completely occupied, about 65 percent of pregnancies will go to full term even when one ovary has been removed several days before mating and the embryos originate from only one side (Fig. 2F). This percentage remains the same when, after removal of the ovary, the uterus is tied tightly to prevent embryos from entering one-third of the horn (Fig. 2G).

When two-thirds of one horn is unoccupied, only 30 percent of the pregnancies continue (Fig. 2H). When a whole horn is unoccupied, none of the pregnancies continue (Fig. 2I), and the gilts come back in heat. Migration of embryos is therefore quite important in helping the gilt decide whether she is pregnant.

When only two or three embryos are present, leaving a large part of the uterus unoccupied, the pregnancy is usually undetected. It is not carried to full term but is destroyed when the gilt returns to heat.

When embryos were flushed from one horn of many different gilts 8 to 10 days after mating, the gilts all returned to heat (Fig. 2J). But 30 percent of pregnancies continued after embryos were removed from one horn at day 12 (Fig. 2K), and all pregnancies continued normally when embryos were removed at day 14 to 40 (Fig. 2L). The gilt apparently decides after day 10, but before day 14, whether to continue with a pregnancy when only one horn is occupied.

The pig uterus apparently can move embryos throughout its length very efficiently and can tell to what extent it is occupied by embryos as soon as 12 days after mating. If the uterus is only partly occupied or if the number of embryos is very small, the gilt returns to heat. This probably prevents many very small litters from being carried to full term.

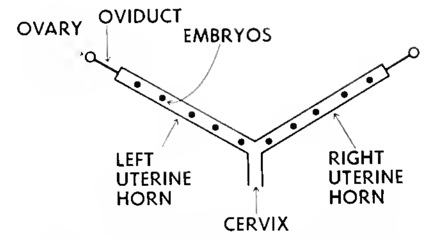
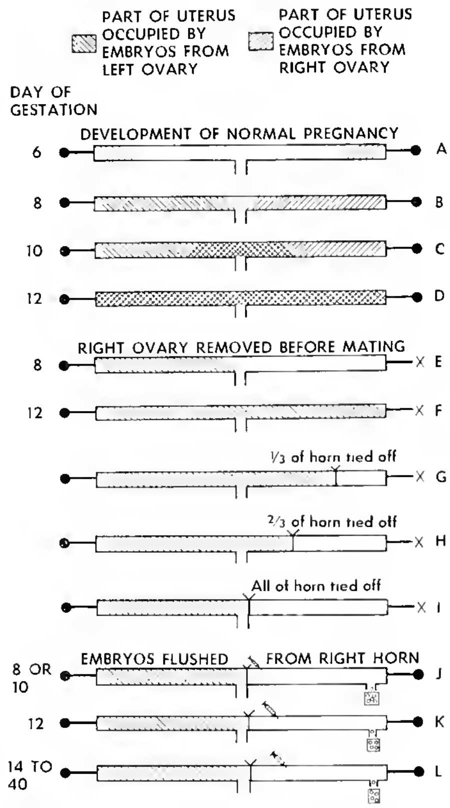


Diagram of sow's uterus and placement of embryos in normal pregnancy. (Fig. 1)



Movement of the embryos through uterus under various conditions. (Fig. 2)

Microscopic Particles in Sterilized Milk Products

H. K. WILSON

ALTHOUGH fresh milk has very limited keeping quality, processed milk products may be kept satisfactorily for months or even years. This keeping quality is related to changes that occur in the size, shape, and distribution of microscopic particles during processing.

The fat in fresh milk before processing consists of tiny globules that vary from 0.00001 to 0.0008 inch in diameter, most of them being between 0.00004 and 0.0002 inch. The largest protein particles are about the size of the smallest fat globules.

In the Food Science laboratory, we have studied particle-size changes in sterilized milk products. Sterilization — which consists of heating products above 300° F. for a few seconds or less — does not leave a strong cooked or caramel taste.

Our microscope can magnify an image 1,600 times, and is equipped with an exposure meter and two cameras. The pictures on this page were taken with a Polaroid camera at a magnification of 1,100.

Figure 1 shows fat globules as they appear in fresh Holstein milk. The largest globule is about 0.00035 inch in diameter. Fat particles in the richer milk from Jersey cows would be larger than in Figure 1. The number of particles, regardless of breed, is estimated at 1,500 billion to 3,000 billion per quart of milk.

Homogenization — by which milk is forced under high pressure through a very small opening — dramatically decreases the size of fat globules. Most of the globules in Figure 2 are less than 0.000039 inch in diameter.

H. K. Wilson is Associate Professor of Dairy Technology, Department of Food Science.

The sample in Figure 2 was homogenized in a two-stage valve assembly with a gauge pressure of 3,000 pounds per square inch at the first valve and 500 pounds at the second valve. The milk was pasteurized, not sterilized, and the temperature at the homogenizing valves was about 150° F.

If the milk had been sterilized, the picture would be essentially the same. Actually the size of protein particles would increase measurably, but not enough to show in the picture.

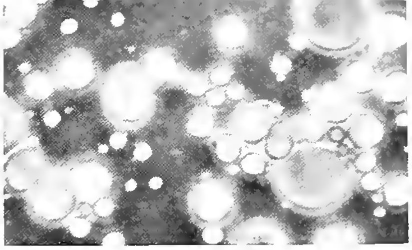
On the other hand, pictures of milk that has been concentrated before sterilization would show the increased particle size, because generally the more concentrated milk is before sterilization, the larger the protein particles are after sterilization. Protein particle size is not greatly altered in milk that is sterilized before it is concentrated.

The cream in Figure 3 had been held more than a year after sterilization. The body of the cream was smooth though thickened, there was no separation, and the flavor was acceptable. The thickening of the body was accompanied by formation of chains of small protein particles. Continued chain formation would result ultimately in gelation.

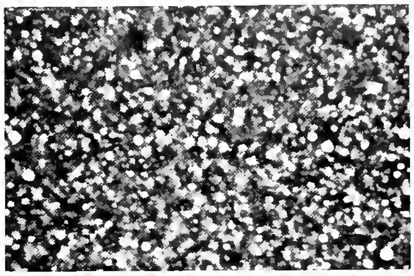
In Figure 4, cream with 50 percent fat is shown three weeks after sterilization. Processing steps were controlled so that most fat globules retained their natural size. With proper dilution, this cream can be whipped and the whipped cream can stand up overnight in a refrigerator without separation or drainage. Creams like that in Figure 3, which was homogenized at high pressure, cannot be whipped by mechanical means, although they can be whipped by aerosol methods.

A defect that results from improper handling of cream is presented in Figure 5. The large clusters of coalesced globules would tend to give a greasy feeling in the mouth.

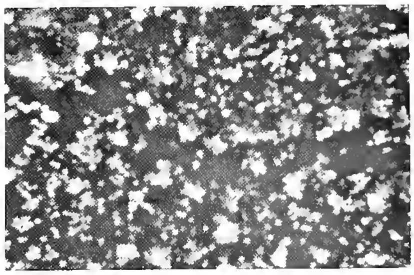
These few examples clearly indicate that an understanding of microscopic changes in milk products is valuable for improved processing and elimination of defects.



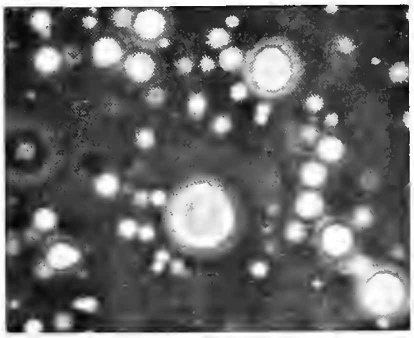
Fat globules in fresh milk. (Fig. 1)



Fat globules in pasteurized homogenized milk. (Fig. 2)



Fat and protein particles in sterilized homogenized cream after storage for more than a year at 40° F. Note the short chains of small particles. (Fig. 3)



Fat globules in sterilized cream containing 50 percent fat. Processing was controlled so that most of the fat globules retained their normal size. (Fig. 4)

Clusters of fat globules with coalesced fat in sterilized cream that has not been handled properly. Smaller particles are small fat globules, protein particles, and complexes of fat and protein. (Fig. 5)

FARM BUSINESS TRENDS

THE PRODUCTION of beef is one of the "big four" agricultural enterprises in Illinois. The others are corn, hogs, and soybeans.

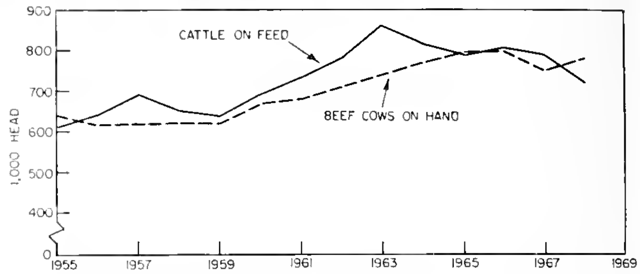
In recent years sales of cattle and calves have brought Illinois farmers about one-half billion dollars per year, or 20 percent of all cash receipts from farm marketings. Hogs usually bring in about the same amount, while corn produces about 25 percent and soybeans around 17 percent.

The beef industry in Illinois consists of two distinct parts: (1) fattening cattle for market, and (2) keeping of breeding herds for the production of calves. Some beef is also produced as a byproduct of dairy enterprises.

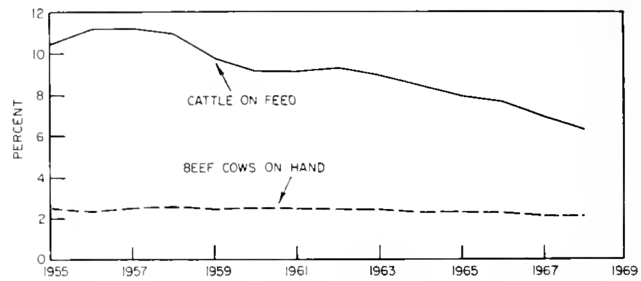
Cattle feeding in the state reached its peak in 1963, when the number of cattle on feed January 1 was estimated at 858,000 head.

Many Illinois cattle feeders have closed their feedlots in recent years. They found that they could make money easier by producing corn, hogs, and soybeans — or by taking part-time employment off their farms. At the same time a substantial number of cattle feeders have been making some profits, and have increased the size of their operations. The total number of cattle fed during the 1967-68 feeding year was down about 7 percent from the high point five years earlier.

While the cattle-feeding industry in Illinois has been shrinking slightly, the total number of cattle fed in the United States has been increasing. Consequently our share of the nation's cattle-feeding business has decreased from over 11 percent ten years ago to less than 7 percent this year.



Number of cattle on feed and beef cows on hand in Illinois on January 1, 1955-1968.



Cattle on feed and beef cows on hand in Illinois on January 1, as percentage of U.S. totals, 1955-1968.

The breeding herd end of the business is holding up better. At the first of the year the number of beef cows on Illinois farms was estimated at 728,000 head, only 2 percent less than the all-time high just two years before.

Beef cows seem to be in a strong competitive position because they utilize grass and other unsalable roughages. — *L. H. Simerl, Professor of Agricultural Economics*

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IN THIS ISSUE

Two types of corn forage are salvaged as economical winter rations for beef cows

Soybean cyst nematodes severely damage fields in southern Illinois

Mass spectrometer is a new tool for solving some old problems

The Morrow Plots are dedicated as a National Historic Landmark (page 3).

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CONTENTS

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M. B. Russell . . . . Director

Margery E. Suhre . . . . Editor, Illinois Research

Departmental representatives: Lowell Hill, Kent Mitchell, J. W. Pendleton, H. M. Scott, K. A. Kendall, Joseph Tobias, C. S. Walters, Aiko Perry, C. Y. Arnold, David Gottlieb, P. D. Beamer.

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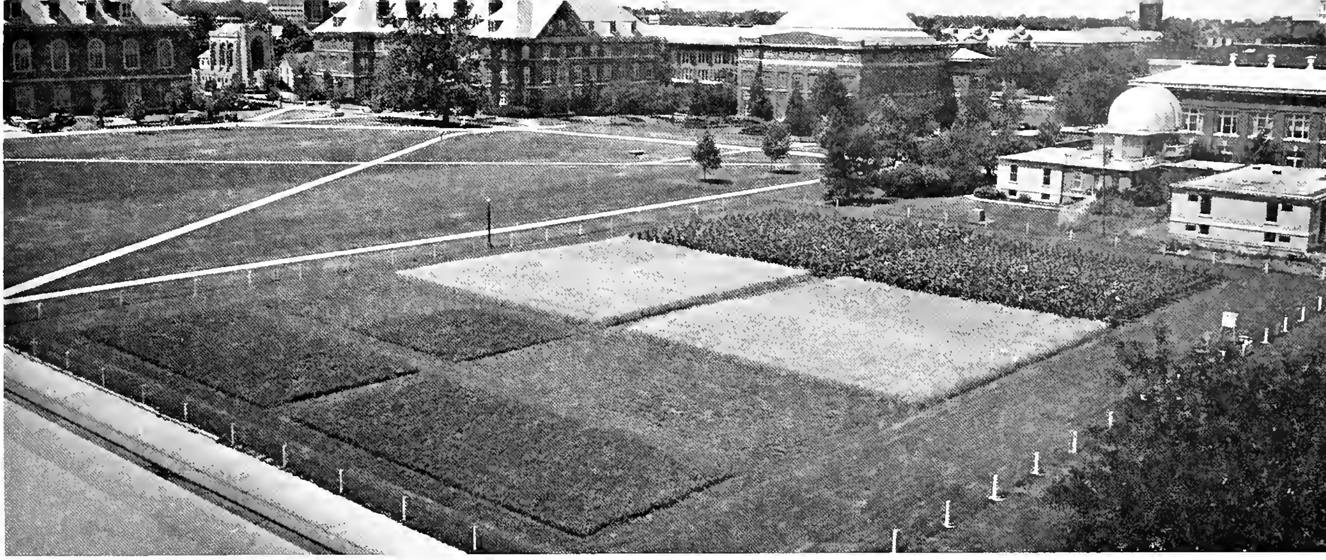
A SYMBOL OF HOPE

The Morrow Plots are a symbol of hope for hungry people throughout the world. They demonstrate that man is not a passive captive of Nature but that, given knowledge, he can manage natural resources and biological production processes to meet more fully his basic needs for food.

Located in a young nation, in an area of high inherent productivity, the Morrow Plots are still very young when measured on the scale of man's ageless struggle for food, shelter, and the meaning of life. In many parts of the world this struggle has ebbed and flowed for thousands of years. In other regions the steady increase in population has caused millions of restless, hungry people to move into new lands in their efforts to find food. What is the meaning of the Morrow Plots to these people? For the hungry people in the densely populated nations where the land has been cultivated since the dawn of civilization, the simple lesson of the malleability of Nature and of man's capacity to understand and apply knowledge is a shining symbol that land, water, sunshine, and the alchemy of the green leaf are renewable natural resources which, if managed wisely, can yield food in perpetuity. To those agricultural pioneers moving into new lands the message from the Morrow Plots is that the inherent productivity of even the most fertile soil is not inexhaustible and that crop yields will quickly decline if exploitive production practices are used. If the land is managed wisely, however, its productivity will not decline but can normally be expected to increase.

It is fitting, therefore, that as the University of Illinois enters its second century, the historic character and broad significance of the Morrow Plots be given national recognition. In its campus setting this bit of historic ground serves as a constant reminder of the timeless truth and broader interpretation of President Draper's perceptive statement, "The wealth of Illinois is in her soil and her strength lies in its intelligent development." The challenge of the search for and dissemination of the knowledge needed for the intelligent use of soil and other natural resources to meet human needs throughout a hungry world is also part of the symbolic hope of the Morrow Plots. — *Excerpted from a speech by Dr. M. B. Russell at the dedication of the Morrow Plots as a National Historic Landmark*



THE MORROW PLOTS—
A National Historic Landmark

The oldest experiment field in America, the Morrow Plots on the University of Illinois campus at Urbana have been designated a National Historic Landmark.

In a dedication ceremony September 12, Allen T. Edmunds of the National Park Service explained that an area must be thoroughly evaluated and screened before being declared eligible for the Registry of National Landmarks by the Secretary of the Interior. "Each selected site," he said, "must possess exceptional significance in illustrating or commemorating the natural character or the historic heritage of the United States."

Mr. Edmunds presented a citation which was accepted by Chancellor J. W. Peltason on behalf of the University. Other speakers included Dean Orville G. Bentley of the College of Agriculture, who presided at the ceremony; President David D. Henry; Congressman William L. Springer; M. D. Thorne, Head of the Department of Agronomy; and M. B. Russell, Director of the Agricultural Experiment Station.

After 92 Years, the Plots Still Provide New Information About Crops and Soils

L. V. BOONE

THE YEAR WAS 1876. Ulysses S. Grant was president of a union of 39 states which was attempting to recover from the tragedy of the Civil War. The United States was populated with fewer than 40 million people and over two-thirds of these lived on farms.

The University of Illinois had been in existence only a decade. The science of agriculture was in its infancy. Only a few farsighted people had the vision to anticipate the need for agricultural research and the imagination to lay down the necessary groundwork. Such men were George E. Morrow and Manley Miles.

Illinois was already famous for its deep black prairie soils that were so admirably suited to corn production. But could the productivity be sustained? If corn were grown year after year on the same field, would the yields decline? How soon would this decline come and how severe would it be? If corn were alternated or rotated with other less depleting crops, would it help to maintain the soil's productivity?

These questions must have been uppermost in the minds of Morrow and Miles as they designed and laid out the study that was called Rotation Experiment 23. The plots on which this study was conducted were later given the name of Morrow.

The original experiment was made up of 10 half-acre plots with various crop rotations established on them. Corn was first planted

L. V. Boone, Associate Agronomist, is responsible for calculating yields and keeping records for the Morrow Plots.

The citation designating the Morrow Plots a National Historic Monument is displayed by speakers at the dedication ceremony. They are (from left to right) Dean Bentley, Congressman Springer, Chancellor Peltason, Dr. Russell, Mr. Edmunds, and Dr. Thorne.

on plot 3 in 1876 and has grown there every year since. Plot 4 was devoted to alternating crops of corn and oats; and plot 5, to a rotation including corn, oats, and clover hay.

These three plots are the only ones that remain of the original 10. Expansion of the growing university caused the original plots to be reduced in both size and number in 1903. The Observatory now stands where plot 1 was located. Mumford Hall was also built on land that was once part of the Morrow Plots.

Fertilizer added in 1904

As the years passed, new facts concerning the productivity of soils and the usefulness of fertilizers came to light. It had been established that the application of limestone, phosphorus, and animal manure increased crop production on soils that had been depleted. In 1904, a program of fertilizing one half of each of the three remaining plots with these materials (MLP) was begun, so that each rotation was grown with and without added fertilizers.

The effects of these rotation and fertilizer treatments became quite marked in the 50 years that followed. By the end of this period, the unfertilized continuous corn was yielding an average of less than 25 bushels per acre, while the fertilized corn in the rotation including legume hay was averaging well above 100 bushels. Hybrid corn, introduced into the experiment in 1937, was a factor in increasing yields on the fertilized plots, but the unfertilized plots were too low in plant nutrients to take advantage of this new development.

Intensive fertilizer in 1955

Another turning point in the history of the Morrow Plots came in 1955. The question of rebuilding depleted soil was raised. Was it possible, using the abundant and inexpensive fertilizer materials then available, to restore to high productivity those soils that had been cropped so long without treatment.[2]

One quarter of each plot (both treated and untreated) was fertilized with limestone, nitrogen, phosphorus, and potassium (LNPK) in amounts it was then thought sufficient to maximize corn yields. These new treatments had little effect on plots already receiving MLP, but on the unfertilized plots the results were astounding.

The first year, the fertilizers more than doubled the yield of continuous corn. The following year (1956) the yield was 29 bushels per acre for the untreated continuous corn and 113 bushels per acre where the continuous corn was fertilized. Thus, the depleted soil could be rebuilt, and how quickly!

The long history of corn every year has been taking its toll, however, in loss of soil tilth. The annual tillage and loss of organic matter is breaking down the structure so that water does not penetrate the soil so easily. Even with adequate amounts of fertilizers, the continuous corn is apparently more vulnerable to moisture stress than is the rotation corn.

Changes in 1967 and 1968

Reflecting the rapidly changing technology in corn production, a further modification was made in 1967, when another quarter of each plot was devoted to a treatment that includes higher levels of LNPK and increased plant populations.

In 1968 there was a rotation change on the Morrow Plots for the first time since 1901. Soybeans replaced oats in the two-year rotation on plot 4. This change, a significant break with tradition, was demanded by the tremendous increase in the acreage and economic importance of soybeans in Illinois.

Now, after 92 years, the Morrow Plots are serving many purposes. Beyond their value as a source of agronomic research results, they also serve as a vivid demonstration of modern crop production practices.

Located in the center of the teeming metropolitan campus of the University of Illinois, they are a living reminder of the purpose for which the University and the Land-Grant system were established.

In this era of almost unbelievably diverse programs at the University, the Morrow Plots serve as a direct link to the past, so that citizens of Illinois and visitors from throughout the country and the world can grasp an echo of the words of Andrew Sloan Draper — "The wealth of Illinois is in her soils and her strength lies in their intelligent development."

Good Yields From No-Tillage Corn

G. E. McKIBBEN

PLANTING CORN in sod without tillage is gaining acceptance throughout Illinois. One reason is that satisfactory planting equipment is now on the market. Also, sod planting was approved on a limited basis as an Agricultural Conservation Program tillage practice for Illinois in 1968. And, most important, the practice has been successful on demonstration plots from extreme southern Illinois to Galesburg in the north.

Since 1962 sod-planted plots at the Dixon Springs Agricultural Center have yielded about as well as conventionally planted plots when comparable stands were established. Yields in 1967, when adequate equipment was available to insure establishment, are given in Table 1.

Of the limited number of chemicals that have been officially cleared for use on sod, 1 quart of paraquat plus 2½ pounds of atrazine has killed the sod most consistently. Atrazine alone at the 5-pound rate has been satisfactory, but a chemical such as paraquat, which kills aboveground vegetation on contact, is desirable in a rank sod growth. The vegetation collapses quicker and doesn't shade the young corn.

The corn should be planted and the sod sprayed as one operation, or spraying should be done right after planting. Spraying before the corn is planted may delay planting, because the killed sod retards drying of the soil. Early spraying also reduces the period of effective weed control after the corn starts to grow.

Although it may be desirable for some of the sod to survive, producing regrowth and providing fall grazing in conjunction with the stalks, this is tricky to do without reducing corn yields. Until more precise chemicals are available, we should aim to kill 90 to 100 percent of the sod.

A chemical such as paraquat should be applied in enough water to thoroughly wet the aboveground parts of the sod. We have found that 64 gallons of water is necessary to kill top growth in ungrazed fescue sod; less water can be used with shorter vegetation.

A spreader should be used with paraquat. If paraquat and atrazine are both used, they can be mixed together.

Follow good corn practices

Regardless of seedbed, good corn-growing practices are necessary to obtain satisfactory yields.

Insecticide should be broadcast before or with the herbicide. Usually we broadcast it in advance when temperatures are down, preferably before or during a shower.

We broadcast phosphorus and potassium on the surface according to soil tests before planting. Nitrogen at normal rates (120 pounds at Dixon Springs), is applied between the rows at layby stage as ammonium nitrate, or anhydrous ammonia is knifed in. Starter fertilizer at 50 pounds per acre is applied to the side or as pop-up, since soil temperatures at planting time are usually 5 degrees lower under the sod than in plowed ground.

Where certain broadleaf perennial plants pose a problem, they can be controlled with 2,4-D.

High-yielding hybrids that are adapted to the desired population and row spacing should be used. Single crosses have proved satisfactory.

Second-year corn

No-tillage planting does not necessarily have to be in sod. For two consecutive years, corn following corn with no tillage has produced yields comparable with those from conventional and plow-plant seedbeds at Dixon Springs (Table 2).

Although not widely tested in Illinois, this practice may hold promise for reducing wind erosion. Stalks could be left standing over winter and rotary-mowed ahead of the planter. If water erosion is a problem, the stalks could be fall-mown. Planting should be on the contour and waterways should not be chemically treated.

Table 1. — Corn Yields in Three Kinds of Seedbed (30-inch rows)[a]

Treatment	Plant population	Yield, bu./A.
Conventional	12,415	124.2
	16,662	159.4
	19,602	153.6
	22,434	162.7
Plow-plant	13,395	142.1
	16,444	163.5
	19,820	172.6
	22,869	175.9
Sod	13,722	109.0
Paraquat, 1 qt.,	16,880	139.9
+ atrazine, 2½	20,147	156.5
lb. (2 lb. actual)	23,958	149.0
Sod	14,702	117.6
Atrazine, 5 lb.	17,860	134.8
(4 lb. actual)	20,691	143.4
	23,958	159.5

[a] 12 percent moisture.

Table 2. — Second-Year Corn Yields in Three Kinds of Seedbed (30-inch rows)[a]

Treatment	1966 Plant population	1966 Yield, bu./A.	1967 Plant population	1967 Yield, bu./A.
Conventional	12,755	117.6	12,560	130.1
	16,798	130.6	16,408	143.6
	18,903	127.8	19,747	160.9
			20,038	163.3
Plow-plant	12,401	105.7	12,778	127.9
	16,036	114.5	17,932	163.5
	18,418	115.4	20,401	160.3
			20,328	153.9
No tillage[b]	12,633	115.0	15,528	133.9
	16,362	122.6	16,843	159.4
	20,473	123.9	20,038	155.0
			20,982	156.4

[a] 12 percent moisture.
[b] Paraquat, 1 qt., and atrazine, 3 lb. (2½ lb. actual) were applied to vegetation in 1966; paraquat, 1 qt., and atrazine, 2 lb. actual, were applied in 1967.

G. E. McKibben is Associate Professor of Agronomy, Dixon Springs Agricultural Center.

A Converted Combine Harvests Corn Forage Along With Grain

Shredded stalks, leaves, husks, and cobs, known as "stalklage," provide an economical maintenance ration for beef cows

D. R. HUNT and L. E. STEPHENS

With the converted combine, the whole stalk is harvested, the grain separated out, and the remaining forage chopped and blown into the trailing wagon.

BEFORE THE DAYS of mechanical harvesting, cornstalk forage was a common livestock ration. But harvesting shock fodder took a lot of hand labor and the practice was pretty well dropped with the advent of the corn picker. Over the years new machines were built which would harvest ear corn and chop the stalks into a second wagon. For one reason or another, however, these machines never became popular.

Corn cobs were plentiful in the age of ear corn harvesting, and some cattle feeders had success in feeding these cobs. Now that field shelling of corn is quite common, neither cobs nor stalks are available as a roughage. Such a situation suggests the desirability of having your cake and eating it too — that is, in this context, having the cash return from shelled corn and yet having a good forage to feed to animals.

Many farmers are currently trying to utilize what's left of the corn plant after the grain has been removed. Flail forage harvesters and conventional forage harvesters have been used over picked fields, but yields have been low and the product is dirty. Some companies sell attachments that permit balers to harvest these fields. And some farmers collect the material exhausted from the combine into small stacks for later processing. In all cases, grain harvest takes precedence over forage harvest. The resulting impasse has been that several tons of unused nutrients rot away on each acre of corn.

As early as 1963 the Department of Animal Science was investigating a base ration of cornstalks for beef cows (page 7). It soon became evident that lack of a practical way to mechanically harvest the stalks was the only barrier to an economic maintenance ration.

The problem of building a corn forage harvesting machine was presented to a senior design class of agricultural engineers. It later grew into a master's thesis project. Two main design criteria were apparent.

1. The machine must be low-cost. Corn forage does not have a high value and since there are many more stalks than there are cows to eat them, a corn forage harvester would be used on only a small percentage of any one farm's corn acreage.

2. The forage-harvesting operation should complement, not compete with, the harvest of shelled corn. In short, a systems approach was needed to integrate the requirements of commercial corn production and those of the stalk-feeding operation.

The eventual proposal was to convert a conventional corn combine into a corn forage harvester. It was reasoned that the corn grower already owned a combine and would continue to do so. Furthermore, since the combine engine is often the most powerful on the farm, it would be well adapted for the high power requirements of a forage-processing machine.

It was proposed that an out-of-production, cut-off corn head replace the conventional corn head and that a chopper be mounted at the rear of the combine. The whole stalk would thus be cut off and fed through the combine cylinder; the grain would be threshed, separated out, and deposited in the grain tank; and the forage, including the cobs, would go back into the chopper,

D. R. Hunt is Associate Professor of Agricultural Engineering; L. E. Stephens is Assistant in Agricultural Engineering.

from which it would be blown into a trailing wagon.

Such a machine was built and is shown in the illustration. A four-row corn combine was used to provide adequate power for the two-row corn-forage harvester. The drive wheel tread was modified to fit the machine into two 40-inch rows and the combine frame was extended to accommodate a 36-inch wide cylinder from a forage harvester. Power to drive the forage harvester was obtained from the beater shaft through two right-angle gear boxes and a drive shaft. The original feeder mechanism of the chopper had to be shortened.

This machine performed adequately in the field. Power was not limiting. The heaviest average loading of 65 horsepower occurred at 4 miles per hour. Of this amount, 37 horsepower was required by the chopper. The yield was approximately 100 bushels per acre of grain at 31 percent wet basis and 6 tons of forage at 50 to 55 percent wet basis. We refer to this forage, which includes stalks, leaves, husks, and cobs, as stalkage.

Nearly all the stalks were chopped into pieces less than 1 inch long, and most of these were split. The light, leafy parts of the plant were often not chopped, but they were thin enough to ensile adequately. Only a few pieces of stalks went through parallel to the chopper's cylinder and even these pieces were not refused by the cattle during feeding trials.

This corn-forage harvesting system seems to be economical. On the basis of representative figures, costs for machinery and silo storage are about $5 per ton for a 70-cow herd.

The system provides the beef producer an alternative to taking land out of cash production and putting it into hay or pasture. The high yield of quality forage makes this system more acceptable than some other proposed systems. It can be used now, as its components are current and recently manufactured. As demand for beef and for shelled corn increases, this system will be even more attractive in the future.

Beef Cows Winter Well on Stalklage Ration

W. W. ALBERT and D. L. COX

One way in which the Illinois cowman can relieve the cost-price squeeze is to utilize corn stalklage (stalks, leaves, husks, and cobs) as a maintenance ration for cows.

Stalklage has been investigated in the Department of Animal Science as part of a project, begun in 1963, to find ways of reducing costs for the beef herd owner. It seemed logical to start with the feed bill, since feed represents about 70 percent of the cost of producing a calf.

Stover meets needs of dry cows

In many Illinois beef herds, calves are born in the spring and are weaned in October and November. A cow suckles her calf about seven months and rests for five.

An average 70-pound calf at birth is analyzed as being about 75 percent water, 20 percent protein, and 5 percent ash, which represents about 17.5 pounds of dry matter. The dry gestation period is thus not a heavy nutritional drain on the cow. During this period, a producer might well economize by using salvage feeds of low market value. The beef cow, as a ruminant, is physiologically well adapted to utilizing such roughages.

As can be seen from Table 1, 18 pounds of dry matter stover would go a long way toward meeting a beef cow's daily nutritive requirements. All that would be necessary would be proper supplementation with protein, minerals, and vitamin A.

Over 75 percent of the 10 million acres of corn in Illinois are harvested annually as grain. There is an increasing trend to combine corn earlier at higher kernel moistures, leaving a greener stover. According to agronomic studies, about 40 percent of the energy of the corn plant remains in the field after grain harvest.

W. W. Albert is Assistant Professor of Animal Science and D. L. Cox is a Graduate Fellow in Animal Science.

Stalklage as it appears at harvest.

Utilization of this energy in a maintenance ration became a practical possibility when the Department of Agricultural Engineering built the specially adapted combine described on page 6.

Methods of ensiling

We have ensiled the stalklage directly after combining, when it is most succulent. It has been successfully ensiled in conventional concrete upright silos, in Harvestore oxygen-free structures, and in piles under plastic by the vacuum seal method. The forage is packed to exclude air and enhance fermentation of carbohydrates to produce preserving lactic and acetic acids.

We have found that adequate moisture and fine chopping favor packing and good ensiling. To avoid musty-smelling stalklage, moisture content should be at least 50 percent, and a higher moisture content, up to 65 percent, is preferable. We have observed that forage moisture is about twice kernel moisture. Thus when grain is harvested at 25 percent moisture the forage will analyze about 50 percent moisture. We have routinely metered water to stalklage

in the conventional silos to raise moisture content to about 65 percent.

Supplements necessary

Since dry stover does not contain enough crude protein for a wintering ration (Table 1), we have studied the use of protein supplements added either before the stalklage was ensiled or when it was fed. Ensiling the supplements with the stalklage increased daily consumption and slightly improved digestibility of dry matter. This was particularly true of nitrogen supplements such as urea and biuret.

Table 2 summarizes a comparison of soybean meal, urea, and biuret supplements in stalklage fed to pregnant ewes. While soybean meal resulted in the best digestibility and nitrogen retention, urea and biuret also gave good results. Because these two supplements are less expensive than soybean meal, we are now ensiling them in our stalklages.

Table 3 gives the amounts of urea and biuret ensiled per ton of forage, as well as the other supplements used. The additions of urea and biuret bring the ration's crude protein content up to about 11 percent. Dicalcium phosphate and trace-mineralized salt are added to supply the cow's mineral needs. Cracked corn and molasses are added because they contain readily available carbohydrates which improve the utilization of urea and biuret and also insure favorable lactic acid formation. We inject each cow with a source of vitamin A at four-month intervals.

Results of feeding trials

Feeding trials in 1966-67 and 1967-68 indicated that the supplemented stalklage was approximately a maintenance ration. During an 81-day period in 1966-67, cows fed urea stalklage from conventional silos gained an average of 28 pounds; on biuret stalklage gained 53 pounds (Table 4). But during a 100-day period in 1967-68, cows on urea stalklage just maintained their weight, while those on biuret stalklage lost 26 pounds. At the same time, cows fed urea stalklage from a Harvestore gained 23 pounds. These cows consumed 2.7 pounds more dry matter daily than the cows fed urea stalklage from a conventional silo. We have observed that cows which are very thin at weaning should gain some weight before being placed on stalklage.

In metabolism studies with paired identical twin cows, the digestibility of dry matter of stalklages averaged 54.7 to 57.8 percent, while the digestibility of dry matter of corn silage averaged about 65 percent. The positive nitrogen balances indicated that both urea and biuret ensiled with stalklage were satisfactory protein supplements.

Cows tend to sort and eat the finer chopped forage first. They did not do any sorting when the forage was rechopped through a 3-inch screen before ensiling or at feeding.

Economically sound

Ensiling stalklage and feeding it as a maintenance ration seems to be sound economically. The machinery and storage costs of $5 per ton for a 70-cow herd would be even less for a larger herd. On a dry matter basis, a ton of stalklage would be valued at about $14, including $4 for protein supplementation, compared with a conservative price of $20 per ton for hay. It would seem that producers could economize and substitute stalklage rations for hay. Hay acres in turn could be converted to cash crops.

Each year of the study, we harvested 5 to 6 tons of 50-percent moisture forage per acre. One acre would thus produce enough roughage to winter two cows for about 120 days. This suggests that 7.5 million acres of combined corn in Illinois offers a tremendous potential of feed for beef cows.

Table 1. — Daily Requirements for a Wintering, Pregnant 1,000-Pound Cow Compared with Approximate Analyses of Corn Stover

	Requirements of cow[a]	Analyses of stover[b]
Dry matter	18.0 lb.	....
Total digestible nutrients	9.0 lb.	48.0%
Crude protein	7.5%	5.1%
Calcium	0.16%	0.4%
Phosphorus	0.15%	0.07%
Vitamin A	20,000 I.U.	.

[a] National Research Council Publication 1137. 1963. For insurance, crude protein and phosphorus requirements were increased by about 40 percent in Illinois studies.
[b] Analyses are on a dry basis.

Table 2. — Effects of Soybean Meal, Urea, and Biuret in Stalklage Rations for Pregnant Ewes

	Soybean meal	Urea	Biuret
	pct.	pct.	pct.
Dry matter	38.13	36.29	32.55
Crude protein[a]	12.50	11.14	11.47
Av. N retained	12.82	9.80	9.00
Av. digestion of dry matter	50.35	48.64	48.42

[a] Dry basis.

Table 3. — Supplements Ensiled per Ton of Stalklage, 1966-67 and 1967-68

Ingredient	Pounds per ton
Urea, 45% N	19.0
or	
Biuret, 37% N	24.0
Corn, ground	75.0
Molasses, dried	25.0
Phosphate, dicalcium	9.3
Salt, trace-mineralized	5.5

Table 4. — Performance of Cows on Stalklage

	Conventional silo, 1966–67		Conventional silo, 1967–68		Harvestore, 1967–68, Urea
	Urea	Biuret	Urea	Biuret	
Days in test	81	81	100	100	100
Number of cows	11	11	11	11	11
Dry matter daily, lb.	19.0	20.5	18.0	18.5	20.7
Gain per cow, lb.	+28	+53	0	−20	+23
Digestion of dry matter, pct.	57.4	54.7	57.8	56.7	56.2
Daily N balance, gm.	+12.4	+16.3	+9.4	+14.9	+13.1

HUSKLAGE: Its Nutritive Value for Wintering Pregnant Beef Heifers

Salvaging and ensiling corn husks and cobs provides an economical and satisfactory maintenance ration

W. W. ALBERT, L. D. FERRELL, and U. S. GARRIGUS

"HUSKLAGE" offers an attractive possibility for cattlemen who are seeking an inexpensive winter ration for beef cows. Consisting of cobs and husks that have been salvaged during corn harvest and then ensiled, husklage has produced satisfactory performance in feeding trials.

As reported in the preceding articles on stalklage, the Department of Animal Science for several years has been investigating ways of cutting the cowman's feed bill. The need for an inexpensive feed for breeding herds has been intensified by the trend to continuous corn on much of the tillable land. This has greatly reduced the amount of rotation hay once traditionally used as the major winter roughage.

Since about 40 percent of the feed energy of the corn plant remains in the field after grain harvest, we have concentrated our efforts on methods of utilizing this potential salvage roughage from the 7.5 million acres of corn harvested as grain in Illinois.

For some time western cattlemen have been using a modified combine to salvage the chaff from wheat harvest. It was reasoned that corn growers could use this adapted combine for salvaging corn husks and cobs without markedly slowing harvest.

A four-row combine is equipped with a recutting blower and powered by an auxiliary motor to salvage husks and cobs during grain harvest.

Table 1. — Corn Forage as Harvested and Fed, 1966-67

Forage	Date of harvest	As harvested		As fed	
		Tons per A.	Moisture, pct.	Moisture, pct.	C. P., pct.[a]
Husklage					
Fine chop	Oct. 26	1.0	42.3	63.0	3.46
Medium chop	Oct. 25	1.1	48.0	63.5	3.33
No chop	Oct. 27	0.95	38.8	60.0	3.38
Stalklage					
With molasses	Oct. 10	6.0	56.0	77.0	5.35
With urea and whey	Oct. 21	6.0	52.0	64.0	10.04
Corn silage	Sept. 28	22.0	64.0	66.0	7.03

[a] Crude protein (dry basis).

Three kinds of forage compared

A study was designed to compare the nutritive value of equal amounts of dry matter from husklage, whole-plant corn silage, and stalklage (husks, cobs, stalks, and leaves) supplemented with equal amounts of crude protein and vitamin A.

The whole-plant forage was harvested with a lawnmower-type chopper. The adapted combine described on page 6 was used to combine grain and to gather and chop the corn stover or stalklage. And the husklage was harvested with a four-row combine equipped with a recutting blower and powered by an auxiliary motor to salvage husks, cobs, and thrown-over grain.

Three types of husklage were ensiled — fine-chop, medium-chop, and no-chop. Medium chop consisted of forage just as it came from the adapted combine, while fine-chop

W. W. Albert is Assistant Professor; L. D. Ferrell, Assistant; and U. S. Garrigus, Professor, all in Animal Science.

Heifers were tied to their stalls for about 8 hours each day.

was similar forage rechopped through a 3-inch screen before ensiling. The cutter knives were removed from the combine for salvaging the no-chop forage.

All forages were ensiled the same way: Stacks of about 20 tons each were enclosed in plastic and ensiled by the vacuum-seal method. Metered amounts of water were added to the stalklage and husklage at ensiling to approximate 65 percent moisture.

Table 1 gives dates of harvest, forage yields, and percent moisture when ensiled and when fed. All forages were harvested from fields yielding about 120 bushels of No. 2 shelled corn per acre.

Heifers in feeding trials

Forty pregnant, long yearling heifers averaging 890 pounds were divided into five equal lots to compare the feeding value of corn silage, stalklage, and the three types of husklage. The feeding trial lasted for 84 days — from November 16, 1966, through February 7, 1967.

All heifers received about 12 pounds of dry matter daily. This was a limited ration, since heifers of this age and weight can eat about 2 pounds of dry matter per hundred pounds of live weight.

The corn silage ration was formulated to meet suggested wintering gains for 800- to 900-pound heifers as recommended by the National Research Council. Each heifer on this ration received 1½ pounds of soybean meal containing 50 percent crude protein and enriched with 20,000 I.U. of vitamin A per pound. This supplement was also fed with the husklage rations. Stalklage fed the first 63 days was ensiled with a urea-whey supplement, while that fed the last 21 days was ensiled with 100 pounds of dried molasses per ton. Soybean meal was fed with stalklage only the last 21 days.

To make sure that each heifer would consume only the feed offered to her, the heifers were tied to their stalls by neck chains from about 8:30 a.m. to 4:30 p.m. A mixture of equal parts dicalcium phosphate and trace-mineralized salt was available to the heifers in their lots.

Heifers perform well

Average daily gains on corn silage, stalklage, and husklage were significantly different (Table 2). Stalklage rations produced gains slightly above maintenance, while husklage rations produced gains about 60 percent as great as those produced by corn silage.

Three heifers on each ration were used for digestion studies. Again significant differences were found, with husklage proving more digestible than stalklage (Table 2).

In this study, with all heifers on a limited ration, no difference in average daily gains and digestibility of dry matter could be attributed to chop size of husklage. Heifers receiving fine- or medium-chop husklage, however, consumed their rations at a faster rate. In 1967-68, rechopping husklage through a 3-inch screen at feeding increased consumption by 30 percent and gave markedly better gains.

During a very cold spell some of the cobs of the no-chop husklage were frozen and were refused. Analyses indicated that no-chop husklage absorbed the least moisture during ensiling (Table 1). According to other studies, fine chopping of forages and moisture of 55 to 65 percent favor better packing and ensiling.

No difference in calving performance could be attributed to ration effects. Among the 23 heifers fed husklage (one heifer was removed from the study because of unruliness) one calf was pulled and another calf presented backwards was dead at birth. One heifer fed stalkage was not pregnant. In the corn silage lot, one calf was born prematurely and a second calf with loose bowels died at 6 days of age. All other calves were healthy at birth.

According to calculations based on Table 1, we harvested about 1,266 pounds of dry matter per acre as husklage. This could furnish 18 pounds for approximately 70 cow-days. The adapter on the combine permitted gathering of the forage without slowing grain harvest. It has been suggested that husks and cobs could be piled in the field for a week or 10 days before ensiling to avoid labor competition with grain harvest.

Labor costs must be kept low if husklage is to provide a cheap winter roughage.

Table 2. — Performance of Heifers on Three Wintering Rations

	Husklage	Stalklage	Corn silage
Forage, lb. daily....	30.0	30.0	35.0
Soybean meal, 50 pct. C. P., lb. daily	1.5	1.5[a]	1.5
Av. daily gain, lb....	0.73	0.11	1.24
Digestibility of dry matter, pct.......	60.0	55.4	65.0

[a] Soybean meal was fed with molasses stalklage the last 21 days only.

Agronomy Keeps Pace With New Computer

S. G. CARMER

THE ABILITY to do several jobs at once is one feature of a new computer now being used to process agronomic research data.

The computer, which is operated by the Department of Computer Science, is an IBM 360 Model 50/75 system. It is replacing the IBM 7094 which has been in use since 1962. Besides having the ability to handle several jobs simultaneously — a feature known as multiple processing — the 360 model is 7 to 10 times speedier than the 7094.

Computers of one kind or another have been used by the Department of Agronomy since 1954 (see ILLINOIS RESEARCH, Fall, 1966). They greatly increase the productivity of research and are, in fact, considered essential for many projects.

S. G. Carmer, Associate Professor of Biometry, Department of Agronomy, mounts Agronomy's disk pack on one of the four IBM 2311 disks included in the University of Illinois IBM 360 Model 50/75 computer system. Use of the disk eliminates the need for a bulky program deck of cards.

Changes in programs

To keep pace with the latest change in computer models, the Agronomy Statistical Laboratory has converted its library of programs for use on the new facilities. The new library contains over 50 programs written in the FORTRAN IV programming language.

These programs fall into the following four categories: (1) randomization of experimental layouts for common experimental designs; (2) preliminary processing of data; (3) statistical analysis of data; and (4) miscellaneous statistical techniques.

While the new programs have been developed primarily to process research data for the agronomy staff, they will also be used by many persons in other departments and divisions of the University.

With the new library, the user of a program no longer needs a large, bulky program deck, which may contain as many as 1,000 cards. Instead, the "object" or machine language version of each program is permanently stored on an IBM 2311 disk, which is a large, mass storage unit directly connected to the computer. Under directions on a small handful of 8 to 12 control cards, a program can be transferred from the disk to the computer in a matter of several seconds. The program is then ready to process the user's data.

In addition, the "source" or FORTRAN IV versions of the programs are also stored on the disk. This means that a copy of the FORTRAN IV statements may be obtained by preparing a small number of control cards that tell the computer to either print or punch out the program.

One advantage of the new library system is that numerous duplicate copies of the bulky "source" and "object" program card decks no longer have to be maintained. Only one copy of each is kept on file in the Agronomy Statistical Laboratory as a backup reserve. This frees space for storing research data.

Another advantage is that employee morale is improved. The number of cards that must be carried back and forth daily from the Agronomy Department, at the south end of the campus, to the computing facilities, on north campus, has been greatly reduced. This in turn reduces the possibility of loss or damage to the cards in transit.

What does the future hold?

The multiple processing feature of the IBM 360 is making it possible to implement a plan known as ILLINET, short for Illinois Network. According to this plan, remote input-output terminals can be located at various spots on the Urbana campus, and even at such faraway points as the Chicago campus.

In the future, the need for prompt, speedy access to the computer will increase. As this occurs, one or more ILLINET stations in the College of Agriculture may become feasible.

THE SOYBEAN CYST NEMATODE
Spreads Through Southern Illinois

D. P. TAYLOR, D. I. EDWARDS, and R. B. MALEK

Despite strict quarantine regulations, a relatively new pest of soybeans has been spreading across the United States. It is the soybean cyst nematode (SCN), *Heterodera glycines*.

Before 1954 SCN was known only in Japan, Manchuria, and Korea. But that year it appeared in North Carolina, and since then it has spread to Tennessee, Missouri, Arkansas, Kentucky, Mississippi, Virginia, Illinois, Indiana, Florida, and Louisiana. Soybean losses due to SCN reached an all-time high in 1967. Missouri alone lost over 2½ million bushels.

Status in Illinois

SCN was first found in Illinois in 1959, infesting a field in Pulaski County. Since then, additional infestations have appeared in Pulaski, Alexander, Massac, Union, Pope, Johnson, Jackson, and Franklin Counties. The northernmost infestation to date is near Benton, about 80 miles north of Cairo. Infested acreage for each county is indicated in Table 1, but these figures probably do not reflect the true extent of the infestations. Very few surveys have been made within the quarantined areas and the nematode has no doubt spread to additional acres.

Estimated losses in 1967 are given in Table 2. Losses were determined by estimating the extent of affected acreage in a field and the amount of growth reduction. Average normal production was assumed to be 25 bushels per acre except in Franklin County, where production was figured at 20 bushels. A price of $2.60 per bushel was used.

Table 1. — Illinois Counties, Properties, and Acreage Infested With SCN, June, 1968[a]

County	Properties	Acres
Alexander	58	6,128
Franklin	2	666
Jackson	4	554
Johnson	7	3,133
Massac	8	1,280
Pope	2	658
Pulaski	59	2,958
Union	3	185
Total	143	15,562

[a] Information furnished by Plant Pest Control Division, USDA, ARS, Urbana, Illinois.

Table 2. — Estimated Losses Due to SCN in Five Counties, 1967[a]

County	Losses	
	Bushels	Dollars
Alexander	11,250	$29,250
Franklin	75	200
Jackson	75	200
Massac	500	1,300
Pulaski	3,750	9,750
Total	15,650	$40,700

[a] Information furnished by Plant Pest Control Division, USDA, ARS, Urbana, Illinois. No loss estimate could be made for Union, Johnson, and Pope Counties, since all infested acreage was planted to corn, a non-host crop.

Damage was especially severe in one field in Franklin County in 1967. About 3 acres contained extremely stunted soybeans which yielded 79 percent less than cyst-free beans in the same field. Exceedingly large populations of cysts were found in the soil and on plant roots in the affected area. Infestations and damage of this magnitude and severity had not previously been found in heavy soil in the state. Such a situation can develop with continuous cropping to soybeans, but this field had been planted to beans only once in the three years before 1967.

At least three different forms (biotypes or pathotypes) of the nematode are known to exist, and the form in this field may be different and more devastating than the one elsewhere in Illinois. Certain morphological characteristics of the infective larvae tend to confirm this suspicion.

Field studies are under way this year to determine whether the Franklin County isolate can be defined. Because living cyst nematodes cannot be moved from quarantined areas to the Experiment Station at Urbana, much-needed basic biological studies of the isolate are not feasible at this time.

What to look for

Soybean losses due to SCN may range from light to over 90 percent, depending on infestation level and other growing conditions. Light infestations may pass unnoticed because of little obvious effect on plants.

Losses will be more severe under conditions of low fertility or drouth than under those optimum for soybean growth. The most striking damage usually occurs in light, sandy soils, but severe injury is also possible in heavy soils, as illustrated by the Franklin County infestation.

The most heavily infected areas of beans in a field are usually round to oval in outline, have a general yellowish cast, and show the most severe damage in the centers. Plants are stunted, become progressively yellowed, and may die. Often nodulation is reduced and roots are extensively rotted. In addition, SCN

D. P. Taylor is Associate Professor of Nematology; D. I. Edwards, Nematologist, USDA, ARS, and Assistant Professor of Nematology; R. B. Malek, Assistant Professor of Nematology, all in Plant Pathology.

SCN-infected (left) and uninfected soybean plants.

may increase the incidence of infection by other soil pathogens.

Unfortunately, symptoms of SCN damage closely resemble those due to other causes. The only specific sign is the presence of white to brown, spherical females, the size of a pinhead, attached to the soybean roots. Positive diagnosis must therefore be made by specialists.

Samples of soil or roots cannot be sent out of quarantined areas or areas of suspected infestation. So if you suspect a nematode problem, contact your county extension adviser. He will arrange for a diagnosis by state or federal specialists.

What to do

Observe quarantine. Strict adherence to quarantine regulations is one way of controlling SCN. Both state and federal quarantines are in force in Illinois. Their main purpose is to prevent the movement of articles from infested to uninfested areas and hence to slow down the spread of SCN.

Each female nematode can produce up to 600 eggs, a new generation is produced every three to four weeks, and as many as four, possibly five, generations can be completed in one season. Therefore, if a single cyst is introduced into an uninfested field, the result could be severe localized damage the following year.

The effectiveness of quarantines in Illinois is difficult to determine. The spread of the pest is perhaps due to natural agencies, such as wind, runoff water, livestock, or wildlife. It is hoped, however, that quarantines will slow down and even prevent the spread of SCN to the central portion of the state — the highest soybean-producing area in the United States.

Use crop rotation. Where resistant varieties are not available, SCN can be controlled by growing soybeans in a rotation with non-host crops. This will reduce nematode populations to a point where near-normal yields can be obtained.

Fortunately, the host range of SCN on crop species is restricted to certain legumes. Many leguminous and a few non-leguminous weeds, however, are highly susceptible and will maintain or increase nematode populations. A field free of weed hosts is therefore a must in any rotation.

Just how many years between soybean crops is best in Illinois is yet to be determined. Rotations recommended for the control of SCN are based on experiments in the southeastern states. Whether these recommendations are optimum for Illinois conditions and cultural practices is now being studied in a long-range experiment in Franklin County.

Pending results of these investigations, a three- to five-year rotation with corn and small grains is recommended. The rotation may also include non-host legumes such as alfalfa and Ladino, red, and sweet clovers, but they are susceptible to the clover cyst nematode. Soybeans should not be grown in successive years, even after a five-year rotation.

Grow resistant varieties. Use of resistant varieties essentially eliminates damage by SCN. Up to now, no resistant variety has been readily available to Illinois growers. Next year, however, growers should be able to get seed of the Custer variety, which is the only resistant variety adapted as far north as southern Illinois.

In 1967 Illinois received enough Custer seed to plant 50 acres of foundation seed. This seed is being increased by certified seed growers and will be available for southern Illinois in 1969. However, the nematode now occurs along the northern margin of the area where Custer is adapted. Should SCN spread northward, Custer will not be suitable.

The U.S. Department of Agriculture and the Missouri Agricultural Experiment Station are conducting cooperative research to develop resistant varieties that mature earlier than Custer. As these become available, we will test them for their suitability to Illinois.

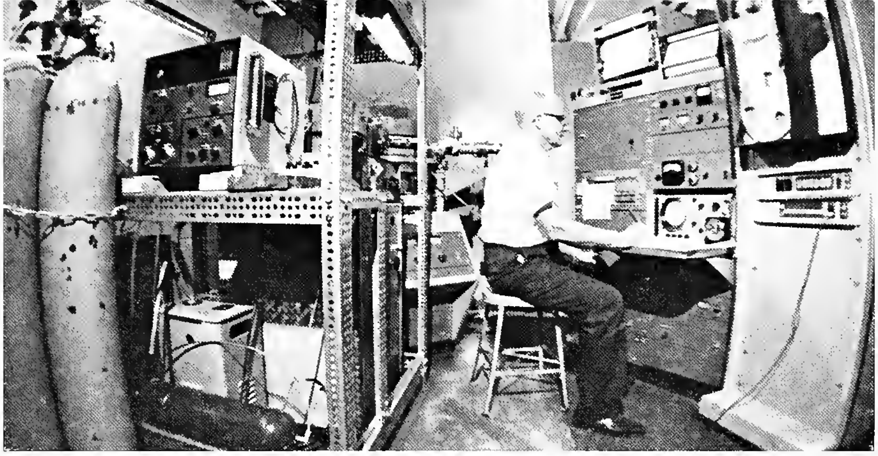
Consider chemical control. If the development of resistant varieties does not keep pace with the northward advance of SCN, then chemical control must be considered as an alternative to long crop rotations. Research is now being conducted in the field to determine which nematocides will control SCN effectively and economically.

Although soil fumigation has significantly increased soybean yields on infested land in other states, this method is not now economically feasible in Illinois because of the cost of fumigants and the necessity for annual applications.

Use certified seed. Contaminated seed stock is now thought to be one way by which SCN is spread. Small balls of soil (peds) that become mixed with seed during harvest can harbor viable cyst nematodes for more than a year. Since no practical method of ridding seed of peds or nematodes has been devised, soybean growers should obtain seed from land certified free of SCN.

Outlook for the future

Although the soybean cyst nematode is spreading in Illinois, the predominantly heavy soils and the widely practiced corn-soybean-small grain rotation may prevent the nematode from becoming a major pest in much of the state. At present the greatest threat lies in continuous bean-cropping on lighter soils. The use of Custer and future resistant varieties, however, will minimize this threat, permitting the continuous production of high-quality soybeans.



Inlet system, analyzer system, and computer interface of mass spectrometer, as photographed with a "fisheye" lens. (Fig. 1)

MASS SPECTROMETRY Makes Research Easier

EDWARD PERKINS and JOSEPH TOBIAS

THE CHEMICALS responsible for characteristic flavors of foods, the fate of nitrogen in the soil, the nature of substances poisonous to livestock — these are some of the problems that can be studied by use of the mass spectrometer that was recently installed in the Department of Food Science.

The mass spectrometer is the first such instrument to be acquired by the College of Agriculture, and is available for research throughout the college.

Mass spectrometry is a technique for separating the ions, or electrically charged particles, produced by fragmentation from a given molecule. The ions are separated in a magnetic field according to their mass-to-charge ratios. As the parent molecule is ionized in the process, its molecular weight can be determined.

The process by which a type of molecule is fragmented is generally predictable. Thus, mass spectrometry can be used to determine molecular structure, or, in other words, to identify chemical compounds.

Ability to produce a vapor is about the only requirement that a material needs to be suitable for study by mass spectrometry. Known chemical groups that increase volatility may be added to certain molecules that are not easily vaporized.

The mass spectrometer works as follows: A vapor of the substance being studied is introduced into an ionization chamber, where it is bombarded by a beam of electrons. This breaks the molecule into a number of smaller fragments (or ions) whose nature depends upon the chemical structure of the original molecule. The positively charged particles are then repelled from the ionization chamber by a positive charge and the resultant beam of ions is further accelerated by an applied voltage. The ion beam then passes through a narrow slit into a magnetic field, where the ions are deflected.

The degree of deflection depends on the mass of the ion. The lower the mass, the greater the degree of deflection. Thus, the molecular fragments are separated into several beams, each containing ions of one mass-to-charge ratio. Since the charge on these ions is normally one, the beams of ions essentially contain particles of a single mass. The various beams are scanned, or brought into focus onto some appropriate recording device. The greater the concentration of a particular size of fragment, the greater the response. Thus, the spectrum can be interpreted according to the abundance of the various fragment ions.

Components of system

When the mass spectrometer was installed in the Burnsides Laboratory, components were chosen with a view to the type of problem which would confront the agricultural research worker.

Practical problems seldom involve just one compound, and introducing a mixture of chemicals into the spectrometer would pose a formidable task in interpretation. An additional difficulty would be the size of the sample available for analysis. All too often the sample is so small as to be actually invisible — and yet it is so important that its identity must be ascertained.

To overcome these difficulties, a gas chromatograph has been installed as part of the mass spectrometer set-up. A gas chromatograph is used to separate mixtures of compounds, in extremely low concentrations, into individual components. As the separated components leave the gas chromatograph, they are directed to the ionization chamber of the mass spectrometer after some intermediate enrichment manipulations. The time necessary for a mass spectral scanning operation is variable at the option of the operator and may be as short as 1 second. At this rate, emerging gas chromatographic components can be easily scanned and their mass spectra determined.

Interpretation of mass spectral data is tedious and time-consuming. It cannot yet be done automatically through a computer system, but certain steps may now be accomplished with the aid of modern computer facilities. Pictured in Figure 1 is a computer interface capable of collecting the mass spectral signal on magnetic tape. With this system it is possible to partially interpret the mass spectral data by use of an appropriate computer program.

Edward G. Perkins is Associate Professor of Food Science and Joseph Tobias is Professor of Dairy Technology, Department of Food Science.

Difficulties encountered

The procedures described so far appear simple enough to provide the necessary information about chemical structure, but the process is not as straightforward as it seems.

A good deal of preliminary work is required to find the conditions that are necessary for separation of a particular mixture of compounds by gas chromatography. Frequently a gas chromatographic column may be found which does an excellent job of separating the constituents but which cannot be used because it is incompatible with the mass spectrometric equipment. The column material must be such that only the desired constituent is allowed to enter the mass spectrometer. If additional constituents are "bled" into the spectrometer, they confuse the pattern of the chemical under study.

Once the mass spectral data are obtained, their interpretation requires a great deal of knowledge of the organic chemistry of the compounds.

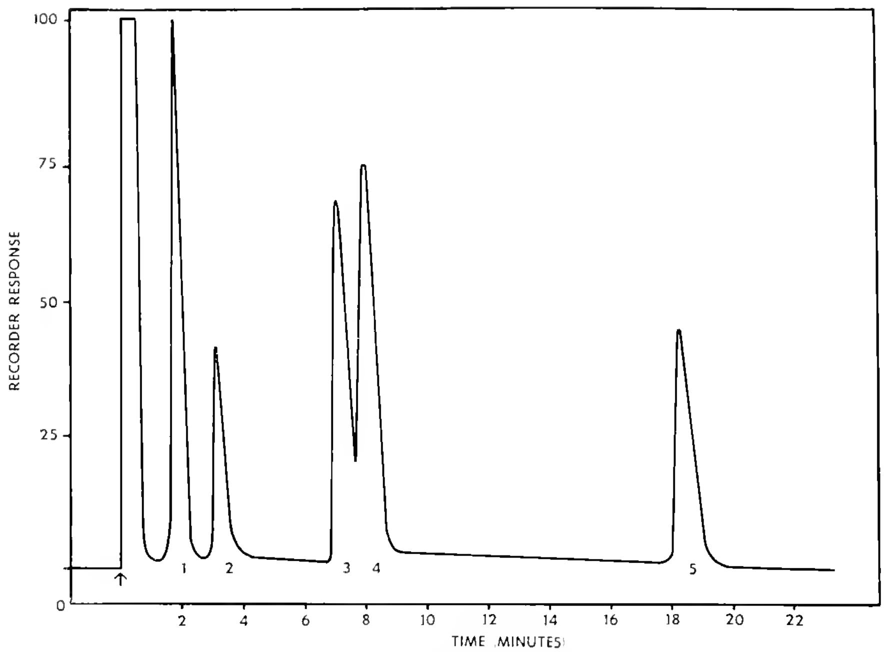
When all the complications have been overcome, the reward is a result which would be impossible to obtain by other means. With mass spectrometry, the chemist can identify a component with the smallest possible sample. For this reason the technique has tremendous potential for the agricultural research worker.

Some applications

One area of work made much easier by mass spectrometry is the study of flavor in foods. Flavor is a subtle quality frequently imparted by concentrations of chemicals so small that they must be measured in terms of parts per million or even parts per billion.

Several years ago, when chemists tried to isolate and identify the flavor chemicals of fruits, they needed literally tons of fruits to get enough chemical to work with. Now, by use of mass spectral equipment and gas chromatography, nearly all the constituents of a fruit may be studied with a much smaller sample — even as little as one strawberry.

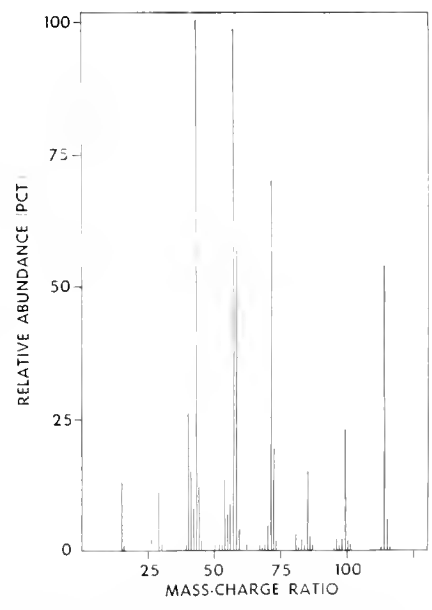
The way flavors are studied is illustrated in Figures 2 and 3. In Figure 2 we see the gas chromatographic pattern produced by a mixture of certain ketones, one of which is a prominent flavor constituent of blue-veined cheese. Figure 3 shows a mass spectral diagram by which it can be ascertained that this particular ketone is 2-heptanone.



Gas chromatogram produced by a mixture of ketones. The lighter constituents are separated from the mixture first. Identification is made by mass spectrometry. (Fig. 2)

Research workers are interested not only in the chemicals responsible for the characteristic flavors of foods, but also in the causes of off-flavors that may render a food unacceptable. It is hoped that with mass spectrometry the causes of off-flavors may be determined and that ways may be found to keep food flavors longer — thus, in essence, preserving our food supplies.

Some other applications of mass spectrometry are based on its potential for detecting compounds labeled with non-radioactive isotopes. The plant pathologist uses this technique to determine the fate of nitrogen in the plant. Similarly, the soil chemist studies nitrogen in the soil. Another use of this technique is to identify poisons and other substances that may be deleterious to the health of animals and plants.



Mass spectral fragmentation pattern of the component represented by peak No. 4 in Figure 2. This component was identified as 2-heptanone, which has a blue cheese odor. (Fig. 3)

The above examples are just a few of the many ways in which mass spectrometry may be applied to agricultural research. The mass spectrometer is not a cure-all for every problem, but it is one of the most powerful research tools we have.

Tree Bark for Growing Potted Plants

J. B. GARTNER, M. C. CARBONNEAU, and D. C. SAUPE

Necessity has become the mother of invention in the Division of Ornamental Horticulture.

Horticulturists wanted a substitute for sphagnum peat moss in growing potted plants. And foresters needed to find a use for wood by-products. The result has been an experiment indicating that bark can replace sphagnum peat as a soil amendment.

Some sort of soil amendment is necessary to provide soil aeration and drainage when plants are grown in containers. In the past, the Division of Ornamental Horticulture has conducted extensive studies with various soil amendments. The most satisfactory growing medium has been a mixture of equal volumes of soil, sphagnum peat moss, and perlite. This medium has been a standard with Illinois growers for the past several years.

A few years ago, Germany was the chief source of peat moss. However, German sphagnum peat has become so expensive that it is almost a rarity. Now most of the sphagnum peat used in the United States is imported from Canada. Even so, shipping costs are higher than many growers can afford.

At the same time, the wood products industries have been receiving pressure to discontinue burning their byproducts, and are looking for uses for these products. The Department of Forestry therefore approached the Division of Ornamental Horticulture about trying bark wastes as a growing medium.

Already west coast growers are substituting redwood bark and sawdust for sphagnum peat. The redwood amendments decompose very slowly, however, and usually do not complicate nutritional requirements as would local species of hardwood bark.

J. B. Gartner is Head of the Division of Ornamental Horticulture; M. C. Carbonneau is Associate Professor of Floriculture Extension; and D. C. Saupe is Instructor in Floriculture.

Geraniums grew well in various mixtures containing bark fiber.

Procedure

A preliminary experiment was conducted with different grades of bark and bark fiber. In each grade, about 60 percent of the material came from oak species and 40 percent from other hardwood species such as beech and maple.

The following grades of bark and bark fiber were obtained from the Mead Corporation of Dayton:

Grade	*Description*	*Particle size, in.*
A . .	Large screenings of bark chunks, no fiber	1/4–3/4
B. . . .	Fiber screenings	1/50–1/4
C. . .	Raw bark fiber	1/50–3[a]
D. . .	Screened bark fiber	1/4–3

[a] 53 percent greater than 1/50 inch.

Another lot of raw fiber, designated Grade E, was obtained from the University of Illinois Department of Forestry. This bark had been hammermilled and stored outdoors for two months at the pulp mill.

The following mixes were made with all grades of bark:

1. ½ bark, ½ soil
2. ⅓ bark, ⅓ soil, ⅓ perlite
3. ⅓ bark, ⅓ soil, ⅓ peat
4. ⅔ bark, ⅓ soil
5. ½ bark, ¼ soil, ¼ perlite

In addition, a check mix consisted of ⅓ soil, ⅓ peat, and ⅓ perlite.

Two cultivars of geraniums (Genie Irene and Improved Ricard) were grown in each mix. Each cubic foot of mix received additions of 453 grams superphosphate, 47 grams hydrated lime, 340 grams agricultural limestone, and 206 grams gypsum. At each watering the plants received 200 p.p.m. of nitrogen in a 20-20-20 water-soluble fertilizer. An automatic watering system was set up to insure that every plant received the same amount of water and nutrient solution.

Preliminary results

All the soil mixes grew salable geraniums. None of the mixes produced any signs of toxicity in the plants.

Heights and weights of the aboveground parts of the geraniums were recorded. According to these measurements, mixes made from the fiber screenings were superior to mixes containing the other types of bark. They compared quite favorably to the standard mix of equal parts soil, peat moss, and perlite.

Work will be continued to determine the levels of nutrition needed to produce healthy, container-grown ornamental plants.

A group of campers learns how to plant seedling pines by machine. Instruction is in small groups whenever possible.

Boys Study Woodland Conservation at ILLINOIS FARM FORESTRY CAMP

W. F. BULKLEY

SINCE 1952, 907 boys have attended the Illinois farm forestry camp, held for one week every year at the Southern District 4-H Camp near West Frankfort. Purpose of the camp is to give interested and qualified boys a practical outlook on the importance of conserving our forests.

Inspired by the success of similar camps in other states, the Illinois Technical Forestry Association voted late in 1951 to sponsor a forestry camp for boys. Foresters of the Cooperative Extension Service were requested to develop a program, and county extension advisers were asked to select boys to attend the camp.

The first year, 11 donors provided financial support for the campers' food, lodging, and use of camp facilities. A number of agencies and individuals furnished other costs of camp operation. Privately owned farmlands, woodland, and equipment were also made available.

Many of the original 11 donors are continuing to support the camp. Others have been added, so that the total number was 39 in 1968. Included in the list are a number of private organizations, soil and water conservation districts, industries, and businesses. In addition, individuals have donated funds to assist particular campers.

W. F. Bulkley is Associate Extension Forester, Department of Forestry.

Boys attending the camp must be between the ages of 14 and 18. They are chosen on the basis of interest in forest conservation and in camping, potential leadership, and desire to get along with others.

In selecting boys, county extension advisers are guided by the advice of 4-H club leaders, teachers, Soil Conservation Service personnel, professional foresters, and other interested individuals.

Enrolment climbed from a low of 39 boys in one of the early camps to a high of 78 in 1966. Camps have proven most successful when enrolment is held to a maximum of 60.

The campers are divided into four crews of 10 to 20 boys. Instructors have found that field trips are most profitable when there are no more than 16 in a crew.

Every day the boys spend about 6 hours on a field trip, during which they receive instruction in tree identification, protection of the forest from fire and livestock, management of native timber and pine plantations, hand and mechanized tree planting, economic harvest of native timber, and preservation of wood products.

The camp is ideally located to permit visits to the State Division of Forestry Fire Control Headquarters, the Dixon Springs Agricultural Center, the Shawnee National Forest, and the Vocational Technical Institute of Southern Illinois University, as well as to a privately owned timber tract, a sawmill, and a wood products plant.

Instructors include staff members of the U.S. Forest Service, Southern Illinois University, University of Illinois, and the U.S. Fish and Wildlife Service, as well as representatives of various industrial concerns. Daily examinations provide a measure of what has been learned.

Special evening programs broaden the camper's experience. A wildlife specialist or a wood industry procurement forester, for example, might describe his particular specialty. Or a staff member of Southern Illinois University or the University of Illinois might develop the whole field of career opportunities in agriculture and related occupations.

Swimming, boating, fishing, softball, volleyball, and amateur dramatics are among the activities that fill out a busy schedule.

Campers are graded on knowledge of forestry gained at camp. In addition, crews are rated on behavior and their record in sports competition, as well as their knowledge, at the end of the week. Awards are made to the boy with the best grades and to members of the crew with the highest ratings.

The camp experience has prompted many boys to investigate careers in agriculture, forestry, and related areas. Among the occupations that campers of past years have entered are forestry, farming, wildlife management, and soil and water conservation, as well as teaching, journalism, business management, and engineering.

Regardless of the camp's influence on career selection, it has provided valuable training in conservation of natural resources. Typical of the boys' reactions is that of one camper, who wrote in 1967: "I learned a great deal at camp and had a lot of fun. . . . This is one experience I will never forget."

RESEARCH IN BRIEF

Chemical Nature of Corn's Resistance to Leaf Blight

A recent advance in corn disease research in Illinois has been the discovery of major gene resistance to the northern leaf blight disease caused by *Helminthosporium turcicum* Pass.

Genetic studies have shown that the resistance is conditioned by a single gene HT_1 located on chromosome 2. The gene has been incorporated into a number of inbred lines by backcross breeding. Within the last two years the Illinois Agricultural Experiment Station has released 57 such blight-resistant lines to seedsmen and the general public. Blight-resistant hybrids are expected to be available to farmers in 1969 and subsequent seasons.

These resistant versions of inbred lines and their hybrids provide ideal resource plants to study the nature of disease resistance. The resistant plants differ from their susceptible counterparts only in the single gene for leaf blight resistance.

Histological studies have shown that the disease-producing fungus grows poorly in resistant leaves, and sporulation is suppressed. Yet no structural barriers to fungal growth have been found in the leaf. Our studies have now shown that resistance is due to the production of a phytoalexin. This is a chemical which is produced by the plant in response to infection and which inhibits the growth of the invading organism.

Spore suspensions of a pathogenic isolate of *H. turcicum* were used to infect resistant and susceptible corn. Plant diffusates or extracts from diseased leaves were tested for inhibitors of spore germination.

In the diffusate method, sections of leaves from resistant and susceptible seedlings were placed on a solution containing 5 percent sucrose and 20 p.p.m. kinetin. Drops of a spore suspension of the fungus were then placed on each leaf section. As a control, drops of water without spores were used. After various periods under a light intensity of 150 to 200 foot-candles at room temperature, the drops were withdrawn and any spores or germ tubes were removed by centrifugation. Drops of these test solutions were then placed on plexiglass slides and fresh spores of the fungus added. Following overnight incubation in a moist chamber, the spores were killed and stained, and the percentage germination was determined.

None of the diffusates from inoculated susceptible leaves or from the control leaves inhibited spore germination significantly. Significant inhibition was obtained from inoculated resistant leaves, but only if the diffusates were collected three or more days after inoculation. By this time spores had germinated and infection had begun.

In the extract method, infected areas from resistant and susceptible leaves were placed in boiling water and left for 16 hours at room temperature. In most experiments, 5 grams of leaf tissue was placed in 50 milliliters of water and the resulting extract was concentrated to 5 milliliters. Extracts were made at various times after the leaves were infected.

The extracts were tested for the presence of material inhibitory to spore germination in the same manner as the diffusates. Such material was found only in infected leaves from resistant plants inoculated 6 or more days before extraction.

Studies are now under way on the chemical characterization of the inhibitory compounds. — *A. L. Hooker, S. M. Lim, and J. D. Paxton*

Farm Families' Accounts Show Less Buying Power

The Illinois Family Account Project is the only one in the United States that has obtained income and expenditure records for 40 years from a group of fairly homogeneous families.

Any interested family that records its income and expenditures in the *Illinois Family Account Book* and sends it to the Department of Home Economics, University of Illinois, at the end of the year may participate in the project. For 1967, 270 usable income-expenditure records were summarized from participating farm and urban Illinois families.

For the urban families, both average total income and average total family living expenditures were 2.8 percent higher in 1967 than in 1966. Since prices also increased by 2.8 percent during this period, urban families, in real terms, were no better off in 1967 than in 1966.

For the farm families, average total income decreased 5.5 percent and average total family expenditures decreased 3.1 percent from 1966 to 1967. Because of the 2.8 percent increase in prices during this period, in real terms, families were able to buy 5.8 percent fewer goods and services in 1967 than in 1966. — *Marilyn M. Dunsing*

The Nature of Action of the Soybean Gene Ps

The resistance of some commercially grown soybean varieties to Phytophthora stem and root rot depends upon a single dominent gene (Ps).

When resistant soybeans are inoculated with *Phytophthora megasperma* var. *sojae* (the organism causing rot), they produce a compound called phytoalexin. This phytoalexin inhibits the growth of the invading microorganism. Production of the compound is initially stimulated by the Ps gene.

All soybeans tested have the ability to produce this phytoalexin when inoculated with the fungus *P. cactorum,* which is not pathogenic on soybeans. However, only the soybean plants containing the gene Ps will produce the phytoalexin when inoculated with *P. megasperma* var *sojae*. Plants lacking the gene Ps do not

produce phytoalexin when inoculated with this pathogen, and ultimately succumb to Phytophthora stem and root rot.

We have been unable to isolate any fungal component which causes the plant to produce phytoalexin under sterile conditions. — *Jack D. Paxton*

Careful Harvest of Good Corn Varieties Increases Profit

Corn profits can be increased by selection of high-yielding varieties that can be harvested with low losses over a long harvest period and by careful operation of the harvesting machine.

Six varieties were harvested at different dates during the adverse harvesting season of 1967-68. According to the results, selecting the higher yielding varieties offered a potential profit increase of 10 to 12 percent, as compared with a possible 4- to 5-percent increase from lodging resistance and timely harvest.

For all varieties, loss was less than 2 percent at the first harvest date, October 20. This loss was below the 10-percent average loss commonly quoted for farm conditions, and indicates that combine shelling can be highly efficient when corn plants are in good condition. The low loss level was obtained by adjusting the machine correctly and by traveling at a slow speed (2.5 miles per hour) that enabled the operator to follow the rows accurately and permitted efficient shelling and harvesting.

Harvesting losses increased an average of one percentage point a month during the harvest season. In the two most weather-resistant varieties, loss increased from 1 percent on October 20 to 2.3 percent seven weeks later. In contract, the loss for two other varieties changed from 1.7 percent to 5.2 percent during the same period. The higher losses were attributed to more lodging in the less weather-resistant varieties.

All varieties withstood the winter weathering better than expected. In a test made in early March, the two most weather-resistant varieties had a harvesting loss of only 2.2 percent. The highest loss for one variety was 8.7 percent, while the average for all six varieties was only 4.5 percent.

Moisture content of the corn changed from 30 percent in October to 24 percent in December and to 18 percent in March. The grain harvested from the weather-resistant varieties was of better quality and had a higher dry matter content than grain from the less resistant varieties. In one variety with poor resistance, lodging caused rotting of the grain and a consequent yield loss of 20 percent. — *H. P. Bateman*

Varietal Differences in Response to Herbicides

Recommendations for using an herbicide have been based on the assumption that all varieties of a given species will respond similarly to the herbicide. This is a false assumption, however, as indicated by experiments with Tupersan on bentgrass, and with TOK on cabbage.

Tupersan. In 1965 commercial-scale damage was observed on putting greens in northeastern Illinois that had been sprayed with Tupersan. In experiments at Urbana in 1965 and 1966, 16 bentgrass varieties responded differently to this chemical. The greatest difference was between the Cohansey and IaGreen-445 varieties. In the greenhouse, low rates of Tupersan (1.5 pounds per acre) reduced growth of IaGreen-445, while extremely high rates (100 pounds per acre) affected Cohansey only slightly.

Experiments were then designed to determine how Tupersan inhibits growth. It was found that Tupersan has little effect on shoot growth, but does inhibit root growth of emerging seedlings and new roots of older plants. This soon places the root and shoot systems out of physical balance. The root cannot supply the shoot with water and nutrients as fast as required, and the plant eventually dies. The reduction of root growth could be stopped if Tupersan were removed from the root zone.

TOK. 1968 was the first year that TOK (E-25) was recommended for postemergence weed control in cabbage in Illinois. Two varieties were used for research in Illinois that led to the recommendation. Some other varieties, however, showed commercial-scale damage when sprayed with TOK this year.

When TOK was evaluated on 36 varieties in replicated plots, injury ranged from none to severe burning and distortion of the cabbage plant. Replicated results were fairly consistent for severely affected or unaffected varieties. More variation was found among varieties with intermediate reactions. All varieties recovered from the initial injury. Further studies are planned to identify the causes for varietal selectivity to TOK in cabbage.

Variety differentiation in response to herbicide is a problem not only for chemical manufacturers and formulators, but also for University personnel who evaluate herbicide performance, and for those who use the herbicide. These studies, together with studies on other crops, emphasize the importance of using an herbicide on a small scale the first time you try it. — *H. J. Hopen and W. E. Splittstoesser*

The Rio Verde cabbage variety was extremely susceptible to TOK (E-25). In tests with 36 varieties, injuries ranged from slight to severe.

FARM BUSINESS TRENDS

PRICES OF FARMLAND may decline during the next year or two. Several signs of price weakness have appeared recently.

Land prices in central and eastern Illinois have been reported weakening during the past 12 months. This area suffered from drouth in 1966 and from excessive rains during the 1967 harvest season. Poor crops almost always depress land values.

Prices in other areas of Illinois and in other midwestern states have held up better. But there are some indications that prices of farmland may slip in those areas.

A USDA release last spring indicated a less bullish attitude toward land values than in most recent years.

Scattered reports indicate that tenants are competing less strongly than before for land. Many farmers are selling out, and the land that they farmed is being offered to other tenants. But many of the better tenants have about all the land that they want. With more land available to rent, farmers will have less need to buy land.

Some landowners may have to make new leases giving tenants a larger share of the profits. This adjustment, plus rising property taxes, would reduce the return to landowners.

The rise of interest rates is another bearish factor in the land market. On the other hand, the rise in interest rates is caused, partly at least, by inflation. And inflation is bullish for land values.

Over the long run, say 10 to 20 years, we expect land prices to rise as inflation and other price-lifting forces continue. But we also expect some periods during which land prices will decline.

Prices of farmland will act like prices of corporation stocks. They will trend upward, with periods of decline. Prices of farmland, however, will not change direction so frequently as does the stock market. A decline in land values might run for three years or more, whereas dips in the stock market usually run only a few months. — *L. H. Simerl, Professor of Agricultural Economics*

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